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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK.....377, 390
Concrete Docks for the Illinois Steel Co., at South Chicago, Ill. (illustrated)..... 378
Improvement of Public Highways in New York State 379
General Structural Details of the New York Rapid Transit Tunnel Ry. (with two-page plate and other illustrations)..... 380
Engineering in the United States Navy; Its Personnel and Materiel..... 382
Portland Cement Testing for Municipalities at the New York State Cement Testing Laboratory..... 387
Notes from the Engineering Schools..... 387
Water Supply and Purification Works at Parkville and Bethany, Mo. (illustrated)..... 388
Book Reviews 390
Annual Meeting of the American Society of Mechanical Engineers. 391
EDITORIAL NOTES 384
The Canadian Canals as Competitors for Export Grain Traffic—The New York Rapid Transit Ry.; What Percentage of Its Gross Earnings will Its Operating Expenses Be?—Long Trips and Short Trips in Street-Car Traffic—The Traffic Awaiting the Rapid Transit Road.
EDITORIAL:
What Shall We Do With the Trusts?..... 384
LETTERS TO THE EDITOR..... 386
Records of Deep Borings for the New York State Geological Survey (Correction)—An English Predecessor of the Centrifugal Railway—Stiffening Thin Pipes of Large Diameter—Gravel vs. Broken Stone Concrete — Black-Print Processes for Copying Drawings—Concerning One Sort of Trade Journalism.

GRAIN TRANSPORTATION on the Great Lakes during the past season has amounted to but 35% of the total shipped from Chicago, 65% having gone by rail, according to newspaper reports, on account of the high lake rates on grain. In former years the proportions were reversed. It is predicted that next season not more than 25% of the grain from Chicago to the seaboard will go by water unless there is a revolution in rates.

ERIE CANAL TRAFFIC FOR 1899 is given as follows by Superintendent of Public Works Partridge: Total tons carried, 3,686,309; with 2,425,759 tons eastbound and 1,260,759 tons westbound. This tonnage was made up of 1,692,972 tons of through and 1,993,079 tons of way freight; with 1,164,665 tons of the through freight carried east and 528,307 tons carried west. The way freight was in a similar manner 1,260,627 tons east and 732,452 tons west. The total tonnage in 1898 was 3,360,063 tons.

DEEPENING THE CHICAGO RIVER is an improvement worthy of attention, according to the report of Maj. W. L. Marshall, Engineer Corps, U. S. A., recently submitted to the Chief of Engineers and to Congress. The report suggests the following order of work to be adopted:

Lower crowns of tunnels to at least 22 ft. below Chicago datum, and begin to dredge simultaneously to 21 ft., beginning at the mouth of the river and at the junction of the branches. At once vessels of horizontal dimension that now navigate the river can begin to increase their carrying capacity 33 to 70% and thus utilize the channel as rapidly as dredged. Next begin at the junction of the two main branches, remodeling the bridges, substituting center channel bridges with at least 120 ft. clear central spans. On the south branch the spans should be at least 100 ft. in the clear. The north branch is throttled near the junction at Kinzie St. by three obstructive bridges. Ultimately, if the river is to be maintained as the harbor of Chicago, it must be materially widened as well as deepened.

Major Marshall states that the cost of dredging the river will be a mere bagatelle in comparison with the cost of the obstructive property which must be removed and of the new bridges and docks which must be built to secure the full benefits of the deep water channel.

INDICTMENTS FOR CONSPIRACY have been returned by the Federal Grand Jury at Savannah, Ga., against ex-Captain Oberlin M. Carter, B. D. Greene, John F. Gaynor, Edward H. Gaynor, Wm. T. Gaynor and M. A. Connolly. The indictments are said to relate to the work done under direction of Carter, for which he was tried by court-martial, convicted and sentenced.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear end collision on the Denver & Rio Grande R. R. on Dec. 4, between a narrow gage train and a following standard gage train. The accident occurred near Salida, Colo., and resulted in the death of six persons and the injury of four others. A correspondent has sent us the following details concerning the accident:

The narrow gage train No. 5 was flagged at a small bridge in such a position that the rear part of the train stood on a tangent about 200 ft. long, which connects two sharp curves to the right. The tangent and first curve are in a side-hill rock cut with the cut on the right and the river on the left. Train No. 15, not being flagged, crashed into the Pullman sleeper in the rear of No. 5. No. 15 was probably running 12 or 15 miles an hour. The locomotive ploughed nearly half way through the sleeper, crushing the sills, the roof rising up over the boiler and the truck being thrown to one side. The day coach ahead of the sleeper also telescoped into it, the sills riding up over the floor and under the lower berths. The roof of the sleeper cut down under the roof of the day coach. The day coach was just enough narrower than the sleeper to allow it to enter between the side frames of the latter. The sleeper was not vestibuled. The day coach telescoped into the sleeper to within about 6 ft. of the locomotive. Train No. 5 was pushed ahead two or three car lengths. The escape of some of the people in the even-numbered berths is, of course, explained by the fact that the center line of the narrow gage track is to one side of that of the broad gage and the boiler of the locomotive missed the berths on the outside.

A MINE EXPLOSION at Carbonado, Wash., on Dec. 9, resulted in the death of 32 miners. It is said that the ventilation was insufficient.

THE HEALTH OF THE U. S. NAVY AND MARINE corps is reported upon by Surgeon-General W. K. Van Reypen, U. S. N., in his annual report to the Secretary of the Navy. This report shows that in the fiscal year 1898, embracing the operations of war, the active list included 23,986, an increase of 8,152 men over 1897. Notwithstanding war conditions and prolonged cruising in tropical waters, the ratio of admission to the sick list, per 1,000, shows but a slight increase over peace years. The ratio for 1898 was 871.69 per 1,000, as compared with 838.53 per 1,000 in 1895; 777.75 in 1896, and 748.24 in 1897. Of the 173 deaths in the year, 118 were from disease and 55 from injuries. Excluding the 260 lost on the "Maine," the death rate was only 7.21 per 1,000, as compared with 5.59 per 1,000 in 1897.

THE HEALTH OF THE ARMY has been reported upon by Surgeon General Sternberg. From May, 1898, to June 30, 1899, the total number of deaths in the regular and volunteer army was 6,619. Of these, 496 were killed in battle; 216 died by accident; 202 died of gunshot wounds and wounds received in action; 2,774 died of typhoid fever; 476 from malarial fever; 342 from diarrhœa and dysentery, and 135 from yellow fever. Most of these deaths were among the volunteers. The regular army, in December, 1898, had a mean strength of 46,635 men. During the year of war, the ratio of injuries in the regular army was considerably less than in the preceding peaceful year; or 209.23 per 1,000, as compared with 290.08 per 1,000 in 1897, and 257.16 for the mean annual rate of the preceding decade. The total death rate from all causes was 27.55; or 22 from disease and 5.55 from injury. Typhoid fever was responsible for a death rate of 9.74 per 1,000; and the death rate from all causes in the Philippines did not differ much from that in the United States; or as 22.74 to 20.14. Of the new men enlisted 770.47 per 1,000 were native-born Americans; and of the 71,250 examined for enlistment 54,896 were accepted, the remainder not coming up to the standard fixed.

NEW SEWAGE PURIFICATION WORKS FOR MANchester, Eng., have been recommended by Messrs. Baldwin Latham, Percy F. Frankland and W. H. Perkin, Jr., after an investigation which included some experimental work. The commission recommends that after screening the sewage should be passed through the tanks already provided and also through "double-contact beds;" that is, subjected to double filtration. The "tanks should be provided with submerged walls and floating scum-boards, so as to retard the flow of the mineral and organic matters in suspension." The report indicates that these receptacles, which are not covered, would be expected to act as septic tanks. The material in the filter beds would be "clinkers, of such a size as to pass a 1½-in. mesh and to be rejected by a ½-in. mesh," and would be 3.33 ft. deep. The beds would be capable of quick filling and emptying and would be filled and emptied four times in 24 hours, giving a daily capacity of 600,000 U. S. gallons, allowing for a rest of one day in each week. The tanks have a storage capacity of nearly 15,000,000 U. S. gallons and the scheme is based on a dry-weather flow of 36,000,000 U. S. gallons. In time of rains, all flow above the normal would go to an extra area of filter beds some 25 acres in extent. When a tank needed cleaning, "which will be very seldom the case, the report states, part of its liquid contents would be pumped into the sewage channels and go to the other tanks. After a careful consideration of the effect on the bacterial process of the large volumes of manufacturing refuse in the sewage of Manchester it has been concluded that there need be no apprehension on that account.

GARBAGE FURNACES OF THE HORSFALL TYPE have been recommended for Geneva, Switzerland, by M. Ami Wagnon, President of the Municipal Council. Twelve cells are proposed, to be located on land behind the city slaughter houses. A masonry building, with a tile and metal roof, is recommended. To save both space and labor, it is proposed to collect the refuse in carts having detachable bodies, lifting and moving the load by a traveling crane and dumping it in any one of the several cells, as desired. This would save the space usually required for inclined driveways and obviate the need of extra horses to bring the carts speedily to the dumping place. It is proposed to utilize heat from the destructors to drive blowers for forced draft and to operate the traveling crane; also to drive the crushing mills, revolving screens, mortar mill and press for manufacturing artificial flag or building stone from the clinker. Liberal extracts from the Geneva report on refuse disposal, which contained the recommendations just cited, are given in the London "Surveyor" for Nov. 24, 1899.

TRACTION ENGINES are being used by the British army in South Africa for hauling artillery and supplies, and 22 of these engines, weighing 15 tons each, were shipped some weeks ago. By means of drums and wire cables the engines can pull themselves or their wagons out of holes and over rough ground, and some of the engines have cranes fitted to the front end for handling heavy material, or lifting disabled cars. An engine will haul 40 tons of load, and can travel at the rate of 30 to 40 miles per day.

A TIE AND FENCE POST PLANTATION has been set out with 50,000 catalpa trees on a vacant farm near the central portion of Indiana, by the Cleveland, Cincinnati, Chicago & St. Louis Ry. Mr. Geo. W. Kittredge, M. Am. Soc. C. E., informs us that at the present time the road is using white oak ties, the average life of which is about nine or ten years. Catalpa ties have not been tried to any extent, although a sample which was put in the track 15 years ago was recently removed and found to be in a fair state of preservation as far as decay is concerned, but was considerably cut and worn by the action of the rail. It has cost on an average but 1 ct. per tree to set the 50,000 trees, this expense including preparing the ground, cultivating the same, and building a considerable amount of fencing, in addition to the cost and transportation of the trees themselves.

JAPANESE RAILWAY PROGRESS is reported upon by Consul-General Gowey, of Yokohoma, as taken from the last report of the Japanese Railway Bureau. The open mileage given includes state and private lines, but in separate columns. The totals are given for each year, for the periods 1872-1899, but taking the figures for only the five-year periods the growth in mileage open appears as follows:

	Lines.				Lines.		
Year.	State.	Private.	Tot'l	Year.	State.	Private.	Tot'l
1872-73.....	18	..	18	1892-93.....	550	1,320	1,870
1877-88.....	65	...	65	1897-98.....	661	2,287	2,948
1882-83.....	170	...	170	1898-99.....	768	2,652	3,420
1887-88.....	300	293	593				

The building of private lines commenced in 1883-84 with 63 miles; and in 1898-99, the state and private lines in operation and under construction, or chartered, aggregated 5,810 miles. In March, 1899, there were 58 incorporated railway companies with a total paid-up capital of 238,775,000 yen, or $118,909,950. Besides these 26 new companies have been formed under provisional charters, with a total capital of 43,535,000 yen, and a mileage of 809 miles; of the 58 companies mentioned, 42 are actually doing business, though only five of these companies operate more than 100 miles of road. These five larger companies operate 857, 315, 276, 207, and 147 miles of line, the Nippon Co. heading the list. The average cost of construction per mile for state and private lines is given as follows in U. S. money:

	Lines.		Total
Fiscal year.	State.	Private.	average.
1897-98.....	$34,789	$24,887	$27,127
1898-99.....	39,356	28,444	30,879

This increase in cost is the result of the general advance in the price of materials and labor. The total rolling stock of the state and private lines, in March, 1899, included 1,103 locomotives, 3,811 passenger cars, 14,088 freight cars. The total mileage runs for the year was 24,917,429 miles for locomotives; 22,977,460 miles for trains, and 310,667,984 miles for passenger and freight cars, the increase over the preceding year was 21.22 and 20% respectively. In the last fiscal year a total of 99,061,889 passengers were carried, and freight amounted to 9,916,126 tons, beside 36,705 tons of baggage. The total receipts were $15,354,378, made up of $9,786,591 from passengers, $5,134,290 from freight, $292,845 from luggage, $137,701 from mail matter, and $2,951 miscellaneous. With some other receipts added the gross income from state and private lines was $15,786,937, against this is a working expenditure of $8,847,241, showing an aggregate profit of $6,939,676, or 3.3% on the cost of constructing the lines open.

A NEW MEXICAN ELECTRIC RAILWAY system is proposed which would connect the states of Tabasco, Yucatan, Chiapas and Campeche with the railway system of central Mexico. It is called the Southern National & International, and will ultimately be 660 kilos., or 409.2 miles long, and the estimated cost is $14,000,000. Of this sum the federal government would give $6,000,000 and the states of Campeche and Tabasco are to be asked for subsidies. Including the federal grant, $10,000,000 has been subscribed in all. President Diaz, on Dec. 1, officially opened to traffic the new electric street car service in the City of Mexico.

CONCRETE DOCKS FOR THE ILLINOIS STEEL CO., AT SOUTH CHICAGO, ILLINOIS.

In 1890, the Illinois Steel Co. erected four new large blast furnaces at its South Works, at South Chicago, Ill., and what is termed the North Slip was built at the same time to enable ore to be delivered direct from the lake vessels to the ore piles for these furnaces. The south dock of this slip was built of three rows of piles with wales, horizontal braces above the water line, sheet piling, and flooring on caps 12 × 12 ins. Below the floor it was open. The dock was anchored to anchor piles by 1¾-in. rods, at the water line, passing through the lower wales. These rods were 34 ft. long, spaced 10 ft. c. to c. Where the ore load on the dock was expected to be heaviest, the anchor piles were discontinued, and a concrete wall was built, 6 ft. thick, 8 ft. high and about 590 ft. long. The anchor rods passed through this wall and were secured by nuts and bearing plates, or washers. An additional row of piles, just within the rear row, and having front and back wales, formed a part of the repairs required to render it fit for use for the season of 1898. Fig. 1 is a map of the works, showing the North Slip and the South Slip.

Two standard gage shipping tracks and a narrow gage furnace ore track occupied the ground back of the dock. On the standard gage tracks ore was shipped to other plants of the company in 100,000-lb. steel cars hauled by 160,000-lb. locomotives. In addition to this heavy service is the ore pile load. Close to the tracks stand ore piles rising between walls of ore 20 to 25 ft. high. At the eastern part of the docks, the two shipping tracks run into one, stretch out on the dock, and turn southwards in a sharp curve. At this place the ore approaches to within 9 ft. of the dock. These heavy loads are largely increased by the pulling and crushing action of vessels moored to the dock in times of storm, as the slip opens into Lake Michigan. Twice in 1898, owing to sudden fluctuations of the water level due to meteorological conditions, vessels caught their horizontal fender wales under the dock and tore 30 to 40 ft. of the caps and flooring from the piles in spite of the bolting.

By the close of the season of navigation in December, 1898, the dock had become so weak that complete reconstruction was called for. The time available for this work was short, being from the beginning of January to a possible early reopening of navigation in April. A timber crib dock could not be built, as the necessary excavation to carry it to a suitable depth would (by taking away the footing of the sheeting) have caused a landslide by the yielding of the sheeting at the bottom. Had this happened, in addition to the great cost and loss, it would have been impossible to restore the slip, the tracks, and the Brown hoisting machines for unloading the ships, within the time available. A lighter and cheaper wooden dock, such as had been built at first, would have been undesirable on the grounds of insufficient strength, short life, and cost of maintenance. The old dock had already been pushed and crowded forward as much as 3 ft. in some places, and a concrete anchor wall had failed, having bulged in several places under the heavy strain on the anchors.

Fig 2 shows the details of the type of construction adopted, including a concrete dock wall on timber foundations. All timber work of a permanent character is below water. The piles and grillage supporting the concrete superstructure are bolted together by heavy drift bolts which stand 9 ins. above the timbers and thus bond these firmly to the concrete. An element of stability is the weight of materials used, which is over 10 tons per lin. ft. of dock. There are two rows of dock. This precludes placing batter bracing piles which could bear against the grillage and front row of piles. If placed against the second row, the angle of batter (on account of the closeness of the front rows of close-driven piles) would be too slight to be of value. If placed against the third row of piles and longitudinals, then under the action of a land thrust, the piles (having a tendency to straighten up) would tend to cause the wall to tip upwards and forwards. It has been frequently found in this vicinity, however, that piles resist all efforts to pull them, even to the breaking of a 1½-in. chain. In view of all this, it was therefore decided to use batter piles in tension, passing through and strongly bolted to the top of the grillage. They are 35 ft. oak piles, placed 7 ft. c. to c. along the dock, well to the back of the grillage, where they are most effective, and at an angle of 30° from the vertical.

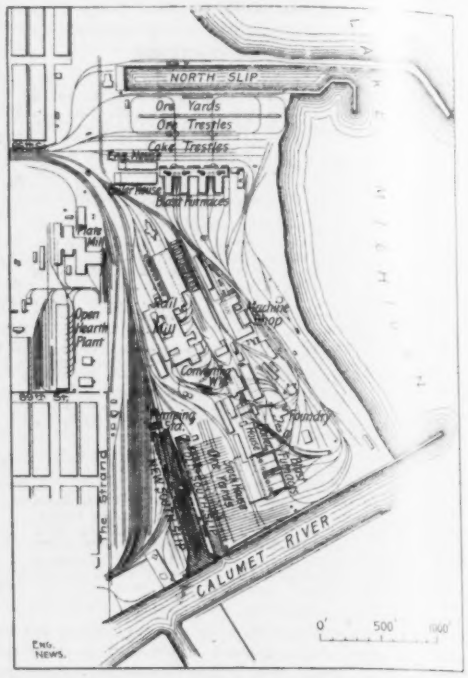

Fig. 1.—General Plan of South Works, Illinois Steel Co., Showing Locations of North and South Slips.

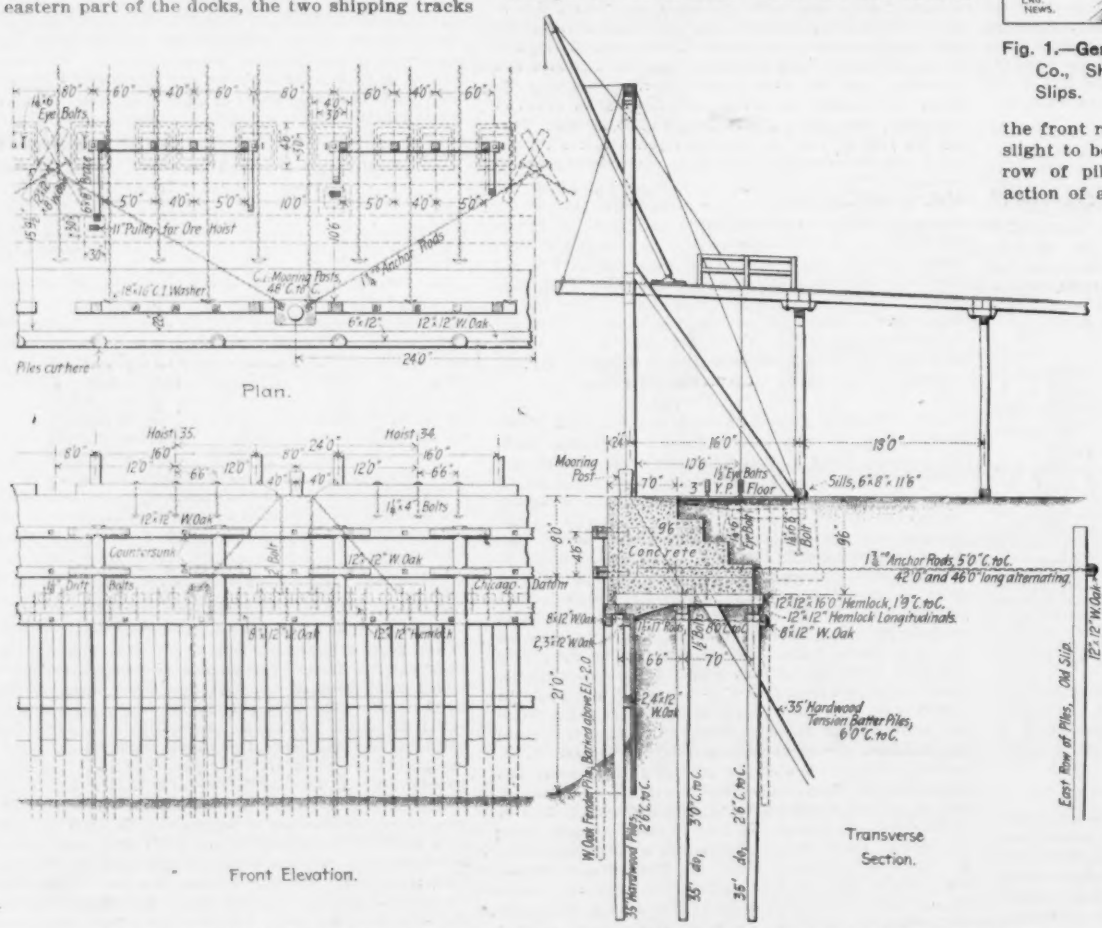

FIG. 2.--DETAILS OF CONCRETE PIER WITH PILES AND GRILLAGE FOUNDATIONS AT THE SOUTH CHICAGO WORKS OF THE ILLINOIS STEEL CO.
Victor Windett, M. W. Soc. C. E., Engineer.
Hausler & Lutz Towing & Dock Co., Contractors.

The space under the grillage is filled with slag to act as a brace and support to the old sheeting. The heavy cast-iron mooring posts on the concrete wall are 50 ft. c. to c., and are strongly anchored to the grillage and to the anchor piles in the rear by diagonal rods and are bolted to transverse timbers set in the concrete. The yellow pine stringers, 12 × 12 ins., which carry the rails for the Brown ore hoists, are laid on the concrete, and secured by vertical anchor bolts.

The concrete wall on top of the grillage is about 18 ft. wide at the base and 8 ft. on top, while the height is 10 ft. 6 ins. on the face. In the top of the concrete are embedded pairs of cross timbers, 19 × 14 ins., of Georgia yellow pine, on the front ends of which are bolted the cast-iron mooring posts. These timbers are covered by the concrete. The bottom of the wall, 18 ins. thick, is made of 1 part of the Illinois Steel Co.'s "Steel Portland" cement, 4 parts of sand, and 8 parts of blast furnace slag. The face, which is 12 ins. thick, has only 4 parts slag. The body of the wall is composed of 1 part Utica (Ill.) natural cement, 3 parts sand and 5 parts slag. The top is laid with a 4-in. concrete

35-ft. oak piles and one of Norway pine, with inside and outside waling pieces of white oak 8 × 12 ins, through which pass the 1¼-in. tie rods, 8 ft. apart. Upon the piles are five lines of hemlock stringers 12 × 12 ins., with caps of the same, 16 ft. long, drift-bolted to the piles.

Vessels of nearly rectangular section and drawing upwards of 18 ft. of water lie close against the

sidewalk finish, and the top corner was chiseled off and plastered with this finish to a radius of 9 ins. The slag was quarried by a steam shovel and used in the mixer with only the rejection of lumps over 4-in. cube, on account of breaking the mixing teeth. The sizes were evenly graded thence down to ½-in. lumps.

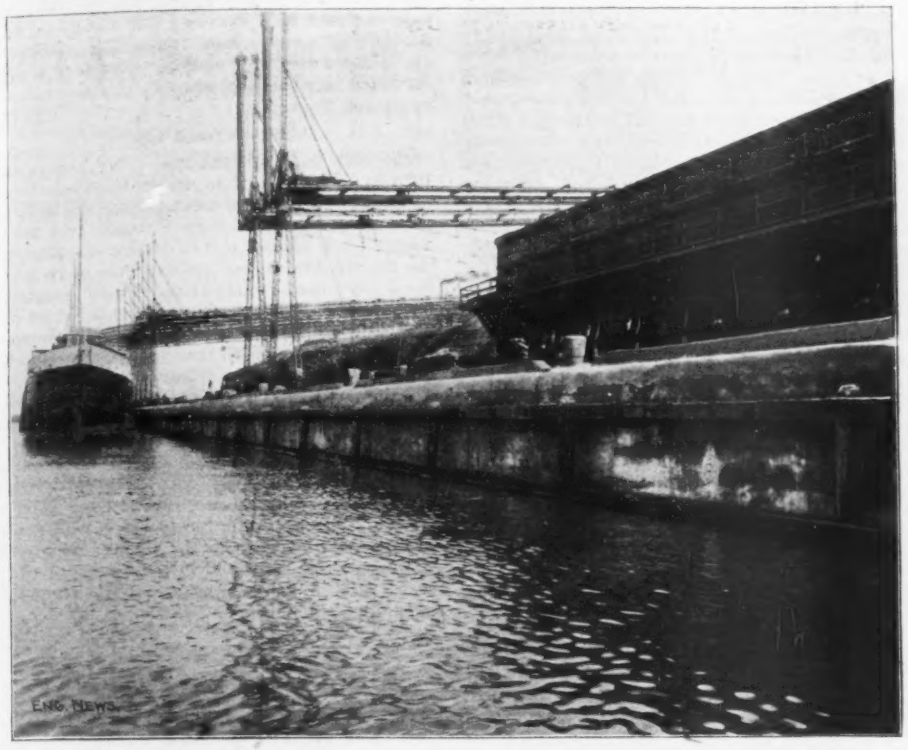

FIG. 3.—VIEW OF CONCRETE PIER, AND CAR DUMPING BACK FILLING.

The wall was built in blocks 25 ft. long, with V-shaped joints, as shown by the plan in Fig. 1. The face of the work is protected by fender piles and two lines of oak waling set between the piles and secured to them by iron straps. The wales are anchored to the wall by horizontal bolts, with heads countersunk in the timbers. On the face of the wall, between the mooring posts, is a guard timber of yellow pine, 12 × 12 ins. All timber work above the top of the wall was done by the Illinois Steel Co.

Fib. 3 is a view of the completed dock, showing the fender protection work, the ore wall and ore piles, and the great Brown ore hoisting and conveying plants. Fig. 4 is a view inside one of the forms for the concrete blocks, and shows the vertical and diagonal anchor bolts in position. In the face of the completed block will be noted the wide vertical V-groove which bonds the blocks together. The planks of the face of the mold are vertical, though they are more generally horizontal.

The work of laying concrete went on day and night in favorable weather, in order to make up for lost time. No concrete was placed when the temperature was below 20° F., and the water used was warmed to about 90° to 100° F. in cold weather. A close continual watch is kept on the dock, and no signs of weakness or defective work have been discovered. The Utica cement concrete was covered with manure in cold weather, but the only protection given the "Steel Portland" concrete was that afforded by the 3-in. planks used as a form or mold for the facing. Although the concrete was laid in such rigorous weather, there has been no necessity for replacing any of the work. Early in the season of navigation, a venturesome vessel-master realized by trial that the dock is better able to resist impact than a heavy ship laden with ore. The happy outcome of his experiment showed the dock and its mooring posts to be immovable; and the place of striking cannot be found by any marks. The ship, however, suffered rather severely. Since then no damage has been done to vessels or dock, although ships at times come up to the dock with considerable speed and check themselves by throwing a line over a mooring post.

The work of tearing out the old dock began Jan. 3, 1899, and concreting was commenced Feb. 17. A week was lost by cold weather, and in addition rain and snow delayed the work. By April 10, two vessel lengths were all complete, ready for the use of ships. On May 5, the east 1,428 ft. of the total length of 1,608 ft. was finished. This was at the rate of over 15 ft. per day for timber and pile work. The concreting of about 7,700 cu. yds. was done in 70 days of actual work, with a maximum record of 143 cu. yds. in 11 hours. In one day of 10 hours, 112 piles, 35 and 40 ft. long, were driven, and 170 were cut off 3½ ft. below water. This handsome record of speed and the excellence of the work reflect credit on the contractors for their skill of execution under trying conditions. The contractors were the Hausler & Lutz Towing & Dock Co., of South Chicago, Ill.

The company was so well satisfied with the economy of construction, and with the condition of this dock after over six months' use, that it is now building at the South Slip another dock 2,300 ft. long of the same type, slightly modified to suit local conditions. This dock is shown in Fig. 5. In the more exposed parts, as at the entrance, "Steel Portland" cement is being used exclusively, but the bottom of the wall is composed of 1 part of this cement to 4 of sand and 8 of slag. The contractor for this dock is Mr. John H. Jones, of South Chicago, Ill.

The engineer in charge of the design and construction of both these docks was Mr. Victor Windett, M. W. Soc. C. E., civil engineer of the Illinois Steel Co., who has taken out patents on this method of construction. We are indebted to Mr. Windett for blue prints, photographs and particulars of this work.

FIG. 4.—VIEW INSIDE FORM FOR CONCRETE BLOCK, SHOWING ANCHOR BOLTS.

STATE IMPROVEMENT OF PUBLIC HIGHWAYS IN THE STATE OF NEW YORK.

With the purpose of keeping citizens in touch with the progress actually being made in the betterment of public highways in the State of New York, State Engineer and Surveyor Edward A. Bond has issued several bulletins which report progress, and call attention to the law, and outline the steps to be taken in order to procure the benefits provided by the act.

Under the law of 1898, governing the improvement of public highways, the State pays one-half of the expense of construction; though the appropriation of $50,000 made in 1898, to carry out the obligation of the State, was so small that little could be done. Some few stretches of road have been built to serve as object lessons and local examples of good road building; and it is expected that their influence will be felt in a larger appropriation for the coming year. In all 79 petitions have been received from 18 counties, representing 450 miles of road in the aggregate; thus showing that the various counties are fully alive to the offer of aid from the State and to a needed improvement on present conditions. Five contracts have been let, covering 15 miles of highway, at a price ranging from $3,784 to $7,295 per mile. At this rate the remaining 435 miles already petitioned for would demand an appropriation much too large to be expected in any one year.

As a practical illustration of the cost to the taxpayers of a road built under the State law, Mr. Bond cites the case of the Deerfield road, 2¾ miles long, and costing $14,686. Of this the State

pays 50%, or $7,343; the county pays 35%, or $5,140; and the property benefited pays 15%, or $2,202. The State's 50% comes out of the $50,000 appropriated in 1898, and amounts to one cent on each $1,000 of assessed valuation for each taxpayer in the State. On the assessed valuation of Oneida County each taxpayer pays 6¾ cts. on each $1,000 to raise the 35% paid by the county; so that each taxpayer in Oneida County paid only 7¾ cts. per $1,000 of valuation for the Deerfield road, in addition to the $2,202 paid by benefited property.

The bulletins show a typical cross-section and give the specifications adopted by the State Engineer for one of the improved sections of highway. They also cover useful directions as to the maintenance of roads and the proper tools to have on hand for this purpose. The importance of wide tires is also pointed out. Copies of these bulletins will be sent to anyone addressing a request to the State Engineer at Albany.

GENERAL STRUCTURAL DETAILS OF THE NEW YORK RAPID TRANSIT TUNNEL RAILWAY.

(With two-page plate.)

The drawings given on our inset sheet, and the accompanying cuts, show the general structural details of the New York Rapid Transit tunnel railway as they have been finally decided upon by the Rapid Transit Commission. In our issue of Nov. 23 we discussed briefly the contract for the construction, lease and operation of this railway. The drawings shown accompany the specifications, which form a part of this contract, and, according to the terms of the contract, they will be amplified whenever it is considered necessary by the engineers of the Commission. The contract also provides that the contractor shall make such working or shop drawings as may be required. The drawings shown here, therefore, are the general contract drawings, prepared by the Commission's engineer, Mr. Wm. Barclay Parsons, M. Am. Soc. C. E.

The first step to a clear understanding of the drawings which we give is a brief description of the proposed route of the railway. As planned for present construction, the road starts from a loop which encircles the triangular area occupied by the City Hall Park and the Post-Office, as shown by Fig. 1. Within this loop the tunnel construction will be two storied, but where the main line leaves the loop all four tracks will come to the same level and continue side by side thereafter, except at the points which will be noted as the description proceeds. Proceeding from the loop, the four-track line passes under Center and Elm Sts., and a few blocks of private property and reaches Fourth Ave., at about Ninth St. From this point, Fourth Ave. and Park Ave. are the routes pursued until 42d St. is reached, when the line turns west along 42d St., which it follows to Broadway. Broadway and the Boulevard (now renamed Broadway) are then followed until 97th St. is reached, when the four-track line is separated into two double-track lines, as will be described further on. The four-track line, between the Post-Office and 97th St., will be known as the main line. In this portion the two inside tracks will be used by express trains, stopping only at comparatively long distances, and the outside tracks will be used by local trains, stopping at stations about ¼-mile apart.

At about 96th St., on the main line, suitable crossovers will be provided, so as to permit trains to pass at will between the northbound local and express tracks, and also between the southbound local and express tracks. At a suitable point north of these crossovers the outside tracks will rise so as to permit the inside tracks, on reaching 103d St., to curve to the right and pass under the right-hand outside track. The inside and outside tracks then take separate routes north as double-track lines. The inside tracks which turn to the right at 102d St., continue east and north to Bronx Park, passing under a portion of Central Park and under the Harlem River in the route. This branch will be known as the East Side Line. The outside tracks turn slightly to the left from the point of separation, and then continue along a route generally parallel to the North River, through Spuyten Duyvil to about 230th St. This branch will be known as the West Side Line. At one point between 123d and 135th Sts. the West Side [illegible] will rise to the surface and pass over a depres[illegible] on elevated structure or viaduct, and for a co[illegible] erable distance both this and the East Side [illegible] will be pure elevated railway construction. [illegible] elevated construction and viaduct; the tu[illegible] under the Harlem River, under Central Park [illegible] under the Fourth Ave. tunnel, and the Post-O[illegible] loop and 96th St. crossovers call for special m[illegible] fications of construction. Except at these p[illegible] the construction will conform closely to a st[illegible] standard construction adapted to four-track [illegible] two-track lines.

Four-Track Line.

The main line, from the Post-Office loop to ab[illegible] 102d St., consists of four tracks built side by s[illegible] in one conduit, except for that portion under [illegible] present Fourth Ave. tunnel, where two para[illegible] double-track tunnels will be employed. Except [illegible] the Fourth Ave. tunnel work, all the work may [illegible] done by open excavation if the contract[illegible] chooses. Referring to Figs. 2 and 3, which sho[illegible] part sections and plan of the standard four-tra[illegible] subway, it will be seen that the construction is al[illegible] concrete carried by a framework of steel. Th[illegible] floor consists, first, of a foundation layer of con[illegible] crete at least 8 ins. thick on good foundation, bu[illegible] made thicker, according to conditions, where th[illegible] foundation is bad. On top of this is placed an[illegible] other layer of concrete with a layer of water[illegible] proofing between the two. In this top layer are[illegible] set the stone pedestals for the steel columns and[illegible] the members making up the tracks. The quality[illegible] of the concrete employed in the floor construction[illegible] varies according to the nature of the ground and[illegible] thickness of the floor, as follows:

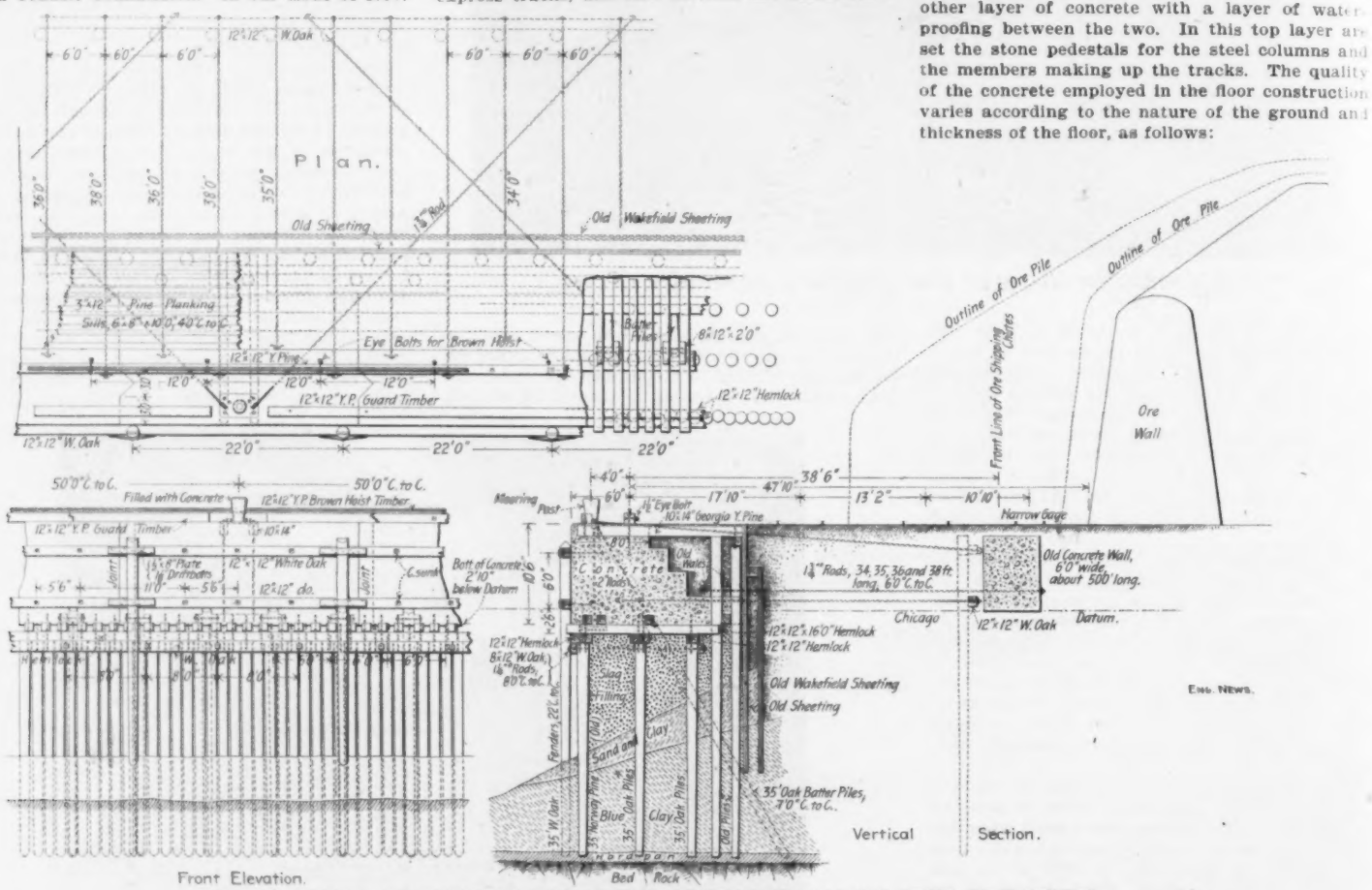

FIG. 5.—DETAILS OF CONCRETE PIER AT THE SOUTH SLIP; ILLINOIS STEEL CO.'S WORKS.
John H. Jones, Contractor.

Foundation bed:		Thickness, ins.	Parts Cement.	Sand.	Stone.
Ground	Wet	24 or less.	1	2	4
	Wet	24 or more.	1	2½	5
	Dry	....	1	2½	5
On rock		12 or less.	1	2½	5
		12 or more.	1	3	6

Portland cement concrete is to be used exclusively, except that in case of foundations over 12 ins. thick on rock, natural cement may be substituted by increasing the amount 30%.

The steel framework consists of transverse bents of columns and I-beams spaced about 5 ft. apart longitudinally of the tunnel. The three interior columns of each bent are built up bulb angle and plate columns of H-section. The same form of column is used for the elevated structure at various points on the north end of the branch

lines. Fig. 4 shows the tunnel column construction. The wall columns are I-beams, as are also the roof beams. Between the I-beam wall columns and roof beams there is a concrete filling of one Portland cement, two sand and four broken stone concrete. The steel specified is open-hearth acid or basic steel; medium steel for main members and rivet steel for rivets. The following physical qualities are required of the steel:

	Steel— Medium.	Rivet.
Maximum phosphorous.....	0.06%	0.04%
Ultimate strength, lbs. pr sq. in.	58,000—68,000	50,000—58,000
Elastic limit, lbs. per sq. in..	33,000	28,000
Elongation in 8 ins.	20%	27%
Reduction of area	44%	54%

The specifications for workmanship call for high-class work throughout, but require no particular mention otherwise.

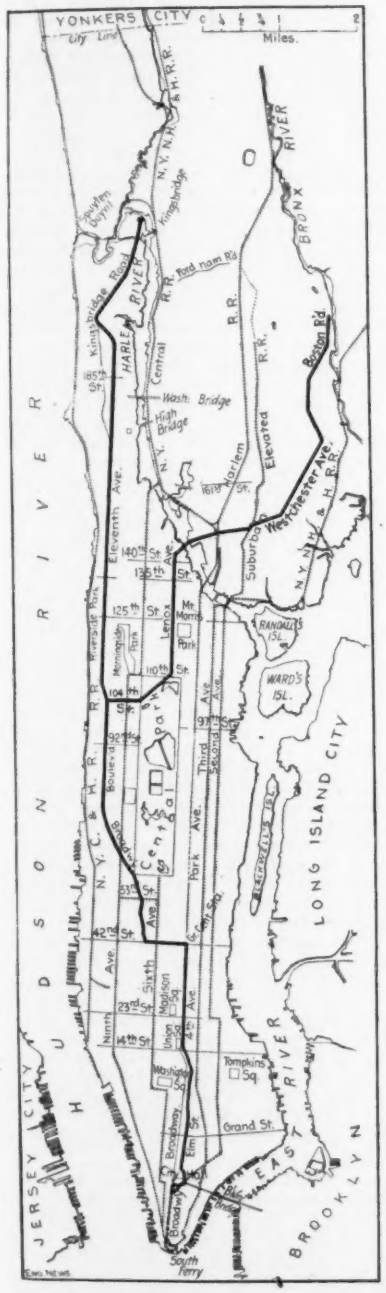

Fig. 1.— General Map of New York City, Showing Route of the Rapid Transit Tunnel Railway. Wm. Barclay Parsons, M. Am. Soc. C. E., Chief Engineer.

Wherever there is masonry to be laid in mortar, the following requirements are specified:

Brick masonry	1 part	Portland cem't,	2	parts sand.
Column footing stones..	1	" "	2	"
Stone masonry	1	" "	2½	"
Rubble masonry	1 part	natural cement,	2	"

It will be observed from Fig. 2, and also from several of the other drawings, that a layer of water-proofing surrounds the entire conduit. The specifications describe the nature and quality of this water-proofing as follows:

It is the very essence of these specifications to secure a railway structure where underground, which shall be entirely free from the percolation of ground or outside water, to which end construction shall be carried out as follows:

After the soil has been excavated to the required depth and dressed off to a true grade as directed by the engineer, there shall be laid a bed of concrete of the proportions as herein described, of such thickness as the local conditions demand, in the judgment of the engineer. On such bed, which shall be made as level and smooth as possible on the top surface, there shall be spread a layer of hot asphalt, and on such asphalt there shall be immediately laid sheets or rolls of felt, all of the quality hereinafter described; another layer of hot asphalt shall be spread over the felt; another layer of felt laid, and so on until not less than two such layers of felt nor more than six be laid with asphalt between each layer, and below and on top. On top of the upper surface of asphalt, the remainder of the concrete as called for by the contract drawings, shall be put in place. In dry, open soil the felt in the floor concrete may be omitted, the base course of concrete being covered with one good layer of asphalt. In rock excavation, where the same is dry and above water level, both the felt and the asphalt in the floor may be omitted.

When the I-beam columns of the side walls are set and secured permanently in place, the concrete composing the side walls shall be rammed in place in such manner that the back or outer face is flush with the outer flanges of the columns. On such outer face hot asphalt shall be brushed and felt spread in alternate layers, in the manner as described for the foundations, and the backing of concrete then added as shown by the plans. Instead of constructing the side walls with the waterproofing, as described above, the contractor may build in dry, open soils, if permitted by the engineer, and if no additional width of excavation is required for sewers or other purposes, a 4-in. brick wall supported at the back by the trench sheathing, laid in cement mortar or hot asphalt, and at a distance of at least 2 ins. in the clear from the line of the exterior faces of the side-wall beams, and to attach to it the layers of waterproofing material as described above, and then to ram around the beams and against the waterproofing surface the concrete composing the side walls. Under similar conditions in dry rock excavation, the rock may be excavated so that no projecting point comes within 3 ins. of the line of the exterior face of the side-wall beams; and then the rough surface shall be made smooth with a plaster of concrete, and on such smooth surface the waterproofing material shall be spread, and then the concrete of the side walls rammed against the same in the manner as described above.

The roof of the structure shall be treated in a similar manner by finishing the jack arches to such a height as directed by the engineer, spreading the asphalt and felt in alternate layers and then adding a cover of concrete, completing the roof as called for by the Contract Drawings.

By the arrangement above described there will be a continuous sheet of asphalt and felt embedded within the concrete of the bottom, top and both sides, and completely enveloping the structure.

The asphalt used shall be the best grade of Bermudez, Alcatraz or Lake asphalt, of equal quality, and shall comply with the following requirements: The asphalt shall be a natural asphalt or a mixture of natural asphalts, containing in its refined state not less than 95% of natural bitumen soluble in rectified carbon bisulphide or in chloroform. The remaining ingredients shall be such as not to exert an injurious effect on the work. Not less than two-thirds of the total bitumen shall be soluble in petroleum naphtha of 70° Baume or in Acetone. The asphalt shall not lose more than 4% of its weight when maintained for ten hours at a temperature of 300° F.

The use of coal-tar, so-called artificial asphalts, or other products susceptible to injury from the action of water, will not be permitted on any portion of the work, or in any mixtures to be used.

The felt used in waterproofing such part of the structure as is below ground water level shall be composed of asbestos or other equally non-perishable material dipped in asphalt and weighing not less than 10 lbs. to the square of 100 ft. The felt used in other parts of the structure shall be the same as the above, or of the best quality of coal-tar felt weighing not less than 15 lbs. to the square of 100 ft., except that if the latter be used, one layer more will be required than of the former. All felt shall be subject to the approval of the engineer.

The surfaces to be waterproofed shall be smooth, without projecting stones, or made smooth where necessary by a coating of mortar made of one portion natural cement to one portion sand, and should be dry before the asphalt is applied.

Means for artificially drying the surface of concrete may be taken by the contractor by blowing warm air over it, or as otherwise permitted by the engineer, but not until the concrete has had at least 48 hours to set.

Each layer of asphalt fluxed as directed by the engineer must completely and entirely cover the surface on which it is spread without cracks or blowholes.

The felt must be rolled out into the asphalt while the latter is still hot, and pressed against it so as to insure its being completely stuck to the asphalt over its entire surface, great care being taken that all joints in the felt are well broken, and that the ends of the rolls of the bottom layer are carried up on the inside of the layers on the sides, and those of the roof down on the outside of the layers on the sides so as to secure a full lap of at least 3 ft.

Especial care must be taken with this detail. None but competent men, especially skilled in work of this kind, shall be employed to lay asphalt and felt.

When the finishing layer of concrete is laid over or next to the waterproofing material, care must be taken not to break, tear or injure in any way the outer surface of the asphalt.

The number of layers of felt on the sides and under the floor shall in no case be less than two in ground that is quite dry, and where there is a water pressure against the masonry equal to 12 ft. not less than six layers. Where the water pressure is less than 12 ft., or where the ground is damp, such number of layers between three and six shall be used as the engineer may direct. The number of layers of felt on the roof shall be not less than three of asphalted asbestos or four of tarred felt.

At any point where the Contract Drawings and the engineer permit, the contractor may lay, instead of the asphalt and felt above described, one or more courses of bricks dipped in hot asphalt of the above described quality, and laid while the coating of asphalt is still hot.

In foundations the contractor may lay, if he prefers, instead of the ordinary concrete with the layer of waterproofing material, as above described, a bed of asphaltic concrete, composed of broken stone of the qualities previously described for concrete, heated in a suitable heater to such proper temperature as the engineer may direct, and when so heated have added thereto the melted asphalt of the quality as described above, and in such proportion as to insure a covering of each particle of stone with asphalt, and the whole mass shall then be thoroughly mixed and incorporated in a suitable mixer. Such asphaltic concrete shall be spread in place and thoroughly rolled and compresed so that it will present a

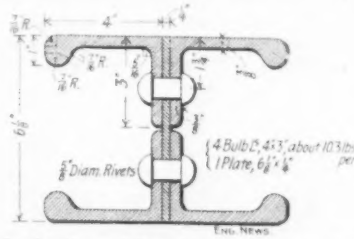

Fig. 4.—Section of Standard Bulb-Angle Column in Subway Line.

smooth, even surface, that will be impervious to water. No asphalt shall be heated to exceed a temperature of 325° F.

In masonry lined structures, where there is no steel work and the ground is dry, the regular waterproofing may be omitted, but in that case, in arched cut and cover work, the extrados of the arch shall be coated with hot asphalt of the quality described or the best grade of refined Trinidad.

Any masonry that is found to leak at any time prior to the completion of this work shall be cut out and the leak stopped, if so ordered by the engineer.

Referring again to Fig. 2, it will be seen that the tracks are an intimate part of the concrete flooring of the conduit. Fig. 5 is a drawing of this construction on a larger scale. The rail rests on a continuous bearing of wooden blocks laid with the grain running transversely with respect to the line of the rail, and held in place by two channel iron guard rails. The guard rails are bolted to metal cross ties embedded in the concrete. The drawings show the principal dimensions of the construction. The wooden blocks are to be white oak, 12 ins. long, 8 ins., 10 ins. or 12 ins. wide, and 4 ins. thick on tangents. The rails are to be laid with broken joints. No special form of rail joint is specified. In chemical composition the railmakers' judgment will be accepted, except that the carbon must not be less than 0.55% nor greater than 0.65%; the phosphorus must not exceed

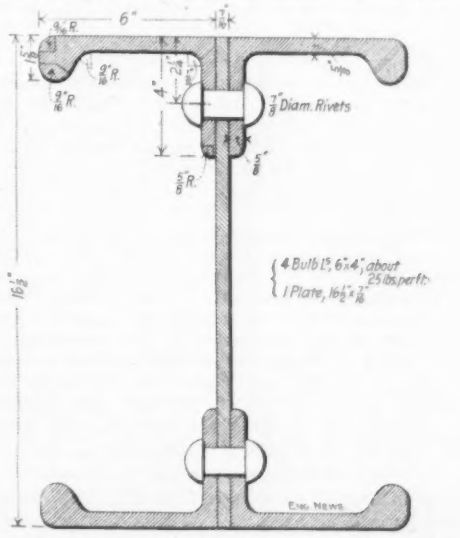

Fig. 14.—Section of Standard Bulb-Angle Column for Elevated Line.

0.085%; the sulphur must not exceed 0.07%, and the silicon must not exceed 0.1%. The specifications for manufacture, workmanship and handling of the rails conform to ordinary good practice in these regards.

Double-Track Subway.

Fig. 6 shows a transverse section of double-track subway for the branch lines north of 102d St. The general construction, it will be seen, is in all respects similar to that of the four-track subway previously described, and this construction is governed by the same specifications for materials and workmanship.

Tunnels.

As planned, there will be three points on the new rapid transit line where the standard subway construction will be replaced by tunnel lines. These tunnels are to be lined with concrete or brick masonry, with backfilling of dry stone, rubble masonry or concrete, as the engineer may decide. Where concrete lining is used it is to be constructed of 1 part Portland cement, 2½ parts sand, and 5 parts broken stone. In wet ground such provisions shall be taken to exclude water from the tunnel as the engineer may deem necessary. The location of the three tunnels will be between 33d and 42d streets, on Park Ave., under Central Park, northeast from 104th St., and under the Harlem River on the route of the East Side Line. The Park Ave. construction will consist of two parallel double-track tunnels located in respect to each other and in respect to the present subway, as shown by Fig. 7. Fig. 8 shows the sections in both earth and rock, which are required for the tunnel under Central Park. This tunnel will be quite deep and will require artificial ventilation. Fig. 9 shows the proposed ventilating shaft and fan arrangement at 104th St. The construction under the Harlem River will consist of two parallel single-track tunnels, lined with cast-iron cylinders, as shown by Fig. 10. This tunnel will pass through soft ground and under the bed of the Harlem River. The drawing shows clearly the character of the construction required.

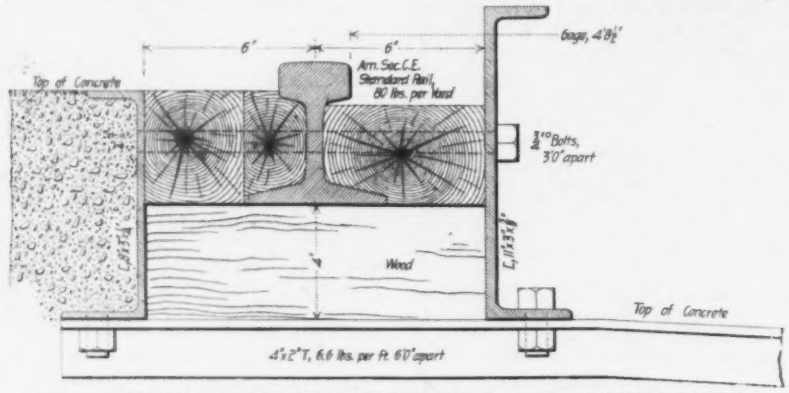

FIG. 5.—STANDARD TRACK CONSTRUCTION IN SUBWAY AND TUNNELS.

Viaduct and Elevated Line.

As previously stated, a considerable portion of the two double-track branch lines north of 123d St., will be viaduct or elevated structure. The viaduct construction will be on the West Side Line, and will extend, including approaches, from 122d St. to very near 135th St. Of this distance 2,018 ft. 8 ins. will be viaduct proper, consisting of plate girder spans carried by trestle bents at the ends and by trestle towers for the central portion. Figs. 11 and 12 show the character of the trestle tower and plate girder construction quite clearly. The approaches proper will be built of masonry. The elevated line proper consists of plate girder spans supported on plate cross girders carried by columns set on the curb lines. Fig. 13 shows the track construction on the elevated and viaduct lines, and Fig. 14 shows the standard bulb angle column section for the elevated lines.

Collateral Construction.

In addition to the construction of the railway itself, it will be necessary to construct or reconstruct certain sewers, and to adjust, readjust and maintain street railway lines, water pipes, subways and other surface and subsurface structures, and to relay street pavement. The specifications provide fully for the methods by which this work shall be done.

ENGINEERING IN THE UNITED STATES NAVY—ITS PERSONNEL AND MATERIAL.*

By Admiral Geo. W. Melville, President Am. Soc. M. E.

Every American is naturally proud of the fact that the first successful steam vessel was the work of an American engineer; but it is not so generally known that the first steam war vessel of any navy was designed by the same American (Robert Fulton) and was built in this very city in 1814. Had the war with England lasted a little longer, there can be no doubt that the "Demologos" would have created a revolution in naval architecture; but the close of the war before she was completed rendered her active service unnecessary, and she was finally destroyed by an explosion of her magazine in 1829.

The advent of the "Demologos" did not create an engineer corps, nor bring any engineers into the navy, so that the real beginning of naval engineering was when the steamer "Fulton" was built, and in 1836 Mr. Charles H. Haswell, the Nestor of engineering in this country, became the first chief engineer in our navy. The "Fulton" was a small vessel of only 1,200 tons displacement, or about what would now be considered a small gunboat; but she was the beginning of what has brought about as great a change in navies as the invention of gunpowder did in warfare.

It is really wonderful to think that the man who was the first chief engineer of this first steam war vessel of our navy is still alive, in full possession of his faculties, and in the active practice of his profession to-day. It is a little hard for the young engineers of to-day, whose training, while it may seem to them beset with difficulties in the way of intricate formulæ and abstruse calculations, is nevertheless complete, and makes them masters of an immense amount of accumulated information, to realize the difficulties under which the older engineers, even of the writer's generation, and much more so of Mr. Haswell's, labored. Mr. Haswell himself was one of the first to provide a reliable book of reference for the young engineer, where the results of experience were systematically arranged; but for Mr. Haswell himself there was nothing of this sort, and he had to create the precedents. When we look at the matter in this light, we are filled with admiration for Mr. Haswell and the men of his generation at their excellent solution of the problems which confronted them.

Some years before our civil war another great marine engineer began to attract attention—Benjamin F. Isherwood. He entered the navy in 1844, so that he is really a contemporary of Mr. Haswell. It is perhaps not exaggerating to say that he is the most brilliant marine engineer whom this country has seen, and his work has made his name known among marine engineers in all parts of the world. His fame will probably rest mainly on his record as an experimentalist, in which field there are few who have ever exceeded him, either in the amount or the excellence of the work done.

The most notable of his experiments was the series which gave the complete demonstration of the relation between cylinder condensation and the rate of expansion. Until these experiments, most engineers believed that the law of Mariotte, that the product of pressure and volume is constant, was strictly applicable to steam as well as to permanent gases, and that a very large ratio of expansion with low pressures of steam would be profitable. Isherwood's experiments on the "Michigan" demonstrated conclusively that under the conditions there obtaining, of a slow-moving engine and a low steam pressure, a ratio of expansion was soon reached beyond which any increase would cause an absolute diminution of economy, instead of an increase thereof, as would have been predicted from a strict adherence to Mariotte's law. Every young engineer knows this thoroughly to-day, and is cautioned about it in his text-books; but so far from its being readily accepted when Isherwood's experiments had demonstrated the true facts, many will remember that he was assailed in the public prints as being guilty either of hopeless ignorance or wilful waste of the government money.

Mr. Isherwood was not only a splendid experimentalist, but a designer of the first rank, and an executive engineer who has not been surpassed. He was Engineer in Chief of the navy during the whole of the War of the Rebellion, and during that time was responsible for a large number of designs. Here again he was criticised from the academic point of view, and yet the very faults for which he is criticised only appear, on proper analysis, the more praiseworthy as excellent details of sound designing. He was accused of building engines which were inordinately heavy, which accusation he has never denied. To the mere office engineer this was true, but he realized, as they did not, that these engines had to go into the hands of men who were largely untrained and unfamiliar with machinery. The ordinary formulas for design allow for reasonably decent handling, and do not provide for the stresses due to ignorance and carelessness. Isherwood knew that the point of first importance was to build engines which would not break down, and, in fact, could not be injured by ignorant and careless handling. The result of this policy was engines very much heavier than would ordinarily be built; but they did not break down, and they carried our ships to victory. To my mind this was the highest proof of his talent as a sound designer. He had the courage to invite criticism from the ablest engineer in order that he might insure success for the country.

You all know the story of the "Alabama," and how she and her sister commerce destroyers drove our merchant marine off the ocean. The Navy Department felt it important to get a class of vessels that would be faster than the "Alabama," or any other vessel likely to be built, so that they could sweep the seas of all these commerce destroyers. A number of designers were concerned in projecting both hulls and engines to accomplish this result, but although the great Ericsson was one of his rivals, Isherwood's ships were the only ones which really accomplished what was intended. The "Wampanoag" was the first of Isherwood's ships to be tried, and she was a magnificent success in every way—really in many ways the greatest success as a steam war vessel that the world has ever known, because she distanced everything that had preceded her so much more than has ever been accomplished before or since. The "Wampanoag" was given a trial lasting 37½ consecutive hours between Sandy Hook and Cape Hatteras, and for the whole run averaged nearly 17 knots per hour. During several 6-hour periods her speed was over 17 knots, and for several single hours she made over 17½. It should be noted also that this was not a smooth weather run, as the trial was ended prematurely owing to a gale, and for some time previous the weather was heavy. The speed made by the "Wampanoag" was at least 4 knots more than that of any other ship—either mercantile or naval—of herperiod, and, in fact, it remained the record speed for many years. Even the first fast cruisers of modern navies, like the "Esmeralda" and "Naniwa," while nominally credited with a higher speed, only made it over the measured mile, or for a short spurt, while the "Wampanoag's" record was, as stated, for more than 37 hours. Another of the Isherwood's ships, the "Ammonoosuc," was given only a short trial, but showed qualities equal to those of the "Wampanoag." The best of the rival ships made a speed of about 15 knots for less than an hour, and the other vessels fell below the "Wampanoag" even more than this.

It is not perhaps generally known that in calling the "Wampanoag" an "Isherwood" ship the designation is more inclusive than might be supposed at first glance, for Mr. Isherwood was responsible for those features of the hull design which affect speed. The design of the hull as a whole was worked out by Naval Constructor Delano, an accomplished naval architect, but he simply took the form of hull as designed by Mr. Isherwood and worked out the structural details necessary to carry out his ideas.

It would be supposed that Isherwood's brilliant achievements would have brought him only gratitude and thanks; but, on the contrary, his vigorous methods had aroused a great many enemies, so that at the end of his second term as Chief of the Bureau of Steam Engineering there was sufficient influence to prevent his reappointment to the office which he had so well filled, and he was banished to the Mare Island Navy Yard; but this only gave him an opportunity for some of his best experimental work, and the famous propeller experiments, which are still a mine of valuable information for designers, were conducted there with the assistance of Mr. William R. Eckart, a former engineer of the navy, and an honored member of this society.

From a remark which has just been made as to the qualifications of many of the engineers who came into the navy during the War of the Rebellion, it might perhaps be inferred that there were few men of real ability; but this would be unwarranted, and would be an entire mistake. The total number of engineers was so large that it was utterly impossible to have even a majority of them skilled men; but a number of talented young engineers came into the service, and the profession generally has learned to recognize their ability from the fact that in the years since the close of the war a large proportion of the leaders in mechanical engineering in our country are men who were naval engineers during the war. The first president of this society (Dr. Thurston), as well as the second (Dr. Leavitt), were naval engineers, and so was that other able man, Charles E. Emery, now gone to his long rest. William Everett, who became famous in connection with the laying of the first Atlantic cable, was another, and so was George Westinghouse, whose wonderful achievements, both as an inventor and as the creator of great industrial works, entitled him to be called the Napoleon of industrial engineering. Theodore Cooper,

*Condensed from the Presidential address at the New York meeting of the American Society of Mechanical Engineers.

a great bridge engineer, and Lay, the inventor of the automobile torpedo, were naval engineers during the war. We must also call attention in passing Chief Engineers to Alex. C. Stimers and Isaac Newton, who brought the original "Monitor" down to Hampton Roads and enabled her to whip the "Merrimac." But for their ability and indefatigable labors the results would have been very different.

During all the period which we have thus far considered, the engineers for the navy had obtained their education outside of naval influence; but in 1866 a class of young men was ordered to the Naval Academy to be trained as engineers in a naval atmosphere. A number of these engineers are still in the service, and were chief engineers of our large vessels during the recnt war with Spain. In 1871 engineer cadets were appointed for the Naval Academy, the course being for two years only, until in 1874 a class was appointed whose course was to be for four years.

These young men were appointed by competitive examination open to the whole country, and as the course became better known the numbers who came to compete increased, and their attainments became so high that an unusually able class of young men was obtained as cadet engineers. Unfortunately for the service, Congress was seized with one of its periodical fits of retrenchment, and as no patronage was affected by abolishing the cadet engineer system, the separate course for engineers was wiped out in 1882, and for a time engineering education dropped out of the curriculum at the Naval Academy.

Curiously enough, just about the time when Congress was undoing the splendid engineering work at the Naval Academy, the Navy Department itself was formulating plans for vessels which should be designed along lines so different from those which had preceded that the familiar epithet applied to them—the "new navy"—is entirely appropriate.

In 1885, when Mr. Whitney became Secretary of the Navy, there was inaugurated a period of great activity and progress in the Navy Department, taking what had been done by Secretary Chandler, who started the new navy, and carrying on the work along the lines of logical development.

I believe it is generally admitted that the machinery of our navy has been in all respects fully abreast of the latest developments, and in many respects we have taken the lead. One of the first things which may be mentioned is the fact that during the period before water-tube boilers were used in any navy, and when in some foreign navies there was a great deal of trouble with the shell boilers, due to the effort to get an abnormally large amount of work out of them, we had no such trouble. We believed in the principle of never sending a boy to do a man's work, and as a result we never had a boiler incapacitated through leaky tubes, and never lost a trial trip on this account, while failures of this sort were very common things abroad.

One of the first things we did was to establish the use of water-tube boilers and light compound engines for our steam launches. Private builders in this country had used water-tube boilers, but the results, owing to the type of boiler employed, were not altogether fortunate. We found a boiler which has proved entirely satisfactory, and also developed light machinery which was also sufficiently substantial to stand the comparatively rough handling with which the machinery of small boats must inevitably meet. We are to-day the only navy which uses water-tube boilers exclusively in its small boats. When we started, the effort was made to save as much water as possible, and small blowers run at a high speed were used for draft, but the inevitable hum caused so many objections to be entered by officers of high rank that we were driven to the use of the steam jet. It was, of course, important that the most economical form of jet should be used, but when we came to determine this question we found that there were absolutely no reliable data in existence. As a result, we carried out a valuable series of experiments at the New York Navy Yard, and found an exceedingly simple form of jet, which was also very economical, giving us a fairly high rate of combustion for a comparatively small expenditure of steam.

It was evident to us that with the prevailing tendency toward continual increase of speed and power, with the accompanying increase of steam pressure, the shell boiler would at some near date have to be superseded by the much lighter water-tube boiler, and we therefore invited a competition among the various manufacturers of water-tube boilers, with a view to determining the one which, all things considered, would be best adapted to naval uses. Although this competition occurred about ten years ago, you are doubtless familiar with the circumstances, and that, as a result, we installed about 5,000 HP. of Ward boilers in the coast defense vessel "Monterey," this being at the time, and for several years, the largest installation of water-tube boilers in any naval vessel. I am glad to say that these boilers have always given satisfaction and are still in use. At this same time water-tube boilers of a different type were installed on one of our torpedo boats, and we have never used any other than water-tube boilers on any of the numerous torpedo vessels which have been built since.

It would have been an easy matter, and it would have brought temporary praise to the Engineer in Chief, if, after the successful trial of the "Monterey," we had at once launched out into the use of water-tube boilers for all our vessels; but we felt that there had not been sufficient experience in their use to warrant us in making such an experiment in our first sea-going armorclads, and consequently for a number of years, and even after foreign navies had begun to use water-tube boilers extensively, we continued to use the shell boilers in our large vessels. Two years ago, when I felt that there had been sufficient experience to warrant us in the final adoption of water-tube boilers, I recommended in my annual report to the Secretary of the Navy that we should definitely adopt water-tube boilers for all classes of vessels. For reasons altogether apart from the machinery, we were not at first successful in securing water-tube boilers in the department's own designs in spite of my urgent recommendation, but the firms which tendered on the government's designs also adopted to guarantee higher speeds if they were allowed to use water-tube boilers and more powerful machinery, in hulls of their own design. This I had advocated very strongly, and both the technical and daily press of the country had supported this position very heartily, believing that it would be a woful mistake for our country to build sixteen-knot battleships when the rest of the world were building ones to make eighteen knots, and when by the use of water-tube boilers we could so readily do it. I am glad to say that the department accepted the builders' offer, thus definitely adopting water-tube boilers and securing the eighteen-knot battleships for which I had worked so hard. At the present time all our new designs include water-tube boilers exclusively.

During our late war with Spain we developed and utilized two engineering schemes which had never previously been tried in actual service—a repair ship and a distilling ship. The former is one phase of the modern method of treating large work by taking the tool to the work instead of bringing the work to the tool. The "Vulcan" was the equal of anything except a very large repair yard, and after the battle of Santiago she was almost invaluable in the much needed general overhaul of all of the ships. Besides an admirable outfit of machine tools and engineering stores, the "Vulcan" was specially notable for using the first cupola ever installed on board ship. The distilling ship was fitted with a four-unit, triple-effect distilling apparatus capable of furnishing 50,000 gallons of fresh water per diem after use for some time with an economy of over 20 lbs. of water per lb. of coal burned under the boilers. With clean coils the "Iris" actually furnished over 100,000 gallons per diem. The bunker capacity is 3,000 tons of coal, thus giving a potential capacity of distilled water of 60,000 tons, or as much as 12 of the largest tank steamers. The advantages of a distilling ship over a "tanker" are very numerous and obvious.

The war with Spain was too short to give a chance for great experience in any line, but the work of the "Oregon" stands out as a brilliant illustration of the fact that the modern battleship is not only the creature of the engineer, but is absolutely dependent upon him for success. You all know the story of Milligan's work as the chief engineer of the "Oregon;" of his ceaseless vigilance to keep everything in order and prevent any deterioration; of how he saved the good coal for the day of battle which finally came (though he was told it never could come), and, above all, how he persuaded Clark, the commanding officer, to have all the boilers ready all the time, although others had steam on only half the boilers and, where it could be done, half the engine power was laid off. I am firmly convinced that the brilliancy of the victory at Santiago is largely due to Milligan's skill and foresight, and, as I said, this case is direct proof that however admirable as a great fighting machine, the battleship is useless except in the hands of trained engineers.

At the present time it seems as though we had practically reached the highest development possible with existing types of machinery for naval purposes, leaving the designer room only for greater perfection in details. We do not, of course, believe that finality has actually been reached, and it is possible that some radical change may take place which will give us a new type of machinery. Some of the more enthusiastic members of the profession think that the steam turbine is to be the successor of the present steam engine, and assuredly the performance of Parson's "Turbinia" is sufficiently remarkable to justify the most careful study and further experiment. It is very interesting in this connection to know that in this country the development of the steam turbine is in the hands of one of our famous engineers, who is also one of the honorary members of this society—Mr. George Westinghouse. He has been developing the steam turbine with special reference to its use in driving electric generators, and some of the results already obtained are very remarkable. With his characteristic energy and courage, he is not satisfied with the results on a small scale, but is now getting out a steam turbine to develop about 2,000 HP. on a single shaft, and when this has been built and thoroughly tested we shall be in a position to appreciate more thoroughly the bearing of this form of prime mover on naval engineering.

At the beginning of this address it was remarked that this was a peculiarly appropriate time for discussing the personnel of naval engineering, on account of the radical change which took place this year in the status of the engineer officers of our navy. For many years, as you all know, there had been an unfortunate controversy in our navy, known as the "line and staff fight," resulting from the fact that the line officers, as the older organization, were unwilling that the staff, and especially the engineers, should have all the rights to which the latter believed themselves, as naval officers, entitled. The great grievance of the engineers was that they held what was called "relative rank" and were denied the command of their men and a military title. On the other hand, the work of the naval engineer on board ship, which had originally been to direct a very few men with small machinery, has been gradually changing, until, on some of our large ships, the chief engineer commanded in fact, although not in name, about half the crew; consequently, his duties had become very largely executive and military, and thus of the same nature as the duties of the line officer. As a result of this state of affairs, many of the more liberal minds on both sides believed that the solution of the vexed question in the navy was the consolidation of the line and engineer corps.

A board of naval officers, presided over by Colonel Roosevelt, then Assistant Secretary of the Navy, finally formulated a scheme for carrying out this idea of amalgamation, which was actually proposed in the board by a line officer (Captain Evans). When it was submitted to Congress two members of the House Naval Committee, Hon. George E. Foss and Hon. A. G. Dayton, took up the measure very actively, and with the assistance of other members of the committee, pushed it forward to complete success, until the Personnel Bill became a law March 3, 1899.

A natural inquiry on your part will be, how successful is this measure in actual practice? To this the answer is that any such change must, of necessity, require time, and it is too early yet to speak of results. I wish, however, to put on record my opinion that if the administrative details necessary to carry the law into effect are worked out with an honest desire to give due effect to its plain intent, and with a desire to make it a success, the results will be all that can be wished, and we shall have the most efficient navy in the world. If, through any unfortunate combination of circumstances, which, however, I can hardly believe possible, there should be any temporary indifference or opposition on the part of those in authority, the result can only be lack of efficiency and disaster in case of war until the intent of the Personnel Board and Congress is put into working effect.

It may occur to some who have only looked into the matter hastily that this scheme of amalgamation is contrary to the spirit of the age, with its tendency toward specialization; but, as an actual fact, the reverse is true. The misapprehension comes from a failure to thoroughly consider the case. When it is proposed to make every naval officer an engineer, we mean an engineer specially fitted for the work to be done in the navy, just as the other training of the line officer is for the duties which come specially to him; in other words, this new line officer—the "fighting engineer"—is to be a specialist in the very best sense of the term; that is, a man who has been specially and thoroughly trained for the work he has to do.

I think we may all feel a pardonable pride in this change in the status of our naval engineers. The amalgamation is analogous to that which occurred in the British navy just after Cromwell's time, and the analogy is not a fanciful nor forced one, but is strictly accurate. Up to the time of that change, naval vessels were manned by soldiers who did the actual hand-to-hand fighting, but were entirely ignorant of seamanship, and another set of men who managed the propulsive power of the vessel, which was then the wind acting on the sails, and who directed the movements of the vessel. These men had no military rank, and were designated simply by professional titles, being known as "the sailing master and his mates." The amalgamation which then occurred was of the soldier and the sailor, and out of this amalgamation was evolved the man-of-warsman and the naval officer. With the advent of mastless ships, we had reached an analogous condition wher one set of people fought the guns and another set managed the propulsive power, this time steam acting through machinery. The new amalgamation has made a new naval officer, "the fighting engineer," to be followed in time by the successor to the old man-of-warsman, who will be the "fighting mechanic." The basis of the new amalgamation is the fact that in this industrial age engineering and mechanical skill are the source of efficiency in our navy, and this, as I have said, is a pardonable cause of pride to all of us as engineers.

In the past, engineering has been hampered at times in our navy on account of the subordinate position which its representatives held in the naval organization; but in the future, as the whole body of naval officers will be engineers, we have every reason to anticipate an era of progress and efficiency greater than has ever been known in the history of navies.

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The Dominion of Canada has spent up to the present time more than $70,000,000 upon its canals, of which over $50,000,000 has been spent on the St. Lawrence system, including in this the Welland Canal, which gives access from Lake Erie to Lake Ontario. The traffic through these canals, however, has always been disappointingly small. Since 1885 the total tonnage of the St. Lawrence canals has varied from 1,500,000 to 2,000,000 tons per annum. If this traffic were charged with the interest on the sums invested in the canals, and the cost of their maintenance and operation, the cost of freight by the Canadian waterways would reach a high figure.

With the completion of the new Soulanges Canal during the past season, however, a depth of 14 ft. of water is secured from the upper Lakes to Montreal, and a determined effort will be made to draw export traffic in this direction in competition with the Lake and railway routes to United States ports. A syndicate, headed by Mr. W. J. Connors, of Buffalo, has obtained from the Montreal Harbor Commissioners a lease of a site for grain elevators and storage warehouses, and has agreed, according to newspaper reports, to bring at least 25,000,000 bushels of grain to Montreal during its first season of operation, and at least 35,000,000 bushels during each following season. It is stated that the plan is to transfer the grain at Port Colborne from the steamers bringing it down from the upper Lake ports to special boats built to pass through the Welland and St. Lawrence canals.

Should the guarantee of the syndicate be carried out, the grain trade of United States ports would be correspondingly curtailed. The total receipts of grain at New York by rail and canal during the season of canal navigation were 96,847,000 bushels in 1896, 120,964,000 in 1897, 112,308,000 in 1898, and 107,848,000 in 1899. It appears pretty clear that the 9-ft. Erie Canal cannot be expected to compete with the 14-ft. Canadian route, especially as the latter has the further advantage that for a large part of the distance the navigation is in a deep and broad river, where full speed is permissible. On the other hand, the New York Central Railroad is hauling grain from Buffalo eastward in solid trains made up of 80 cars of 60,000 lbs. capacity each. If it can solve the question of cheap transfer to ocean-going steamers in the port of New York, under the sharp spur of necessity, we shall probably obtain some new evidence as to the possibilities in economical freight movement by rail.

Our esteemed contemporary, the "Street Railway Journal," has been investigating the Rapid Transit project, and has reached the conclusion that the contractors who operate the road cannot make it a paying enterprise, an opinion diametrically opposite to that reached by us as a result of the discussion printed in our issue of Nov. 23. We estimated that the road would have to earn $3,625,000 per annum for the first five years in order to meet its rental and the interest on the cost of equipment. The "Street Railway Journal" holds that these earnings must reach at least $5,000,000. This difference between its estimate and our own is due almost wholly to the fact that it assumes the operating expenses to equal 70% of the gross earnings, while we set them at only 60%. Our contemporary justifies this higher figure by the remark that "the railway is built avowedly for long distance traffic on a uniform 5-ct. fare," and it is evidently comparing the road with experience on ordinary surface electric railways. It appears to us that this is an unsafe basis for comparison. A more reliable method of estimating the proportion of expenses to earnings on the proposed Rapid Transit road is to compare it with the existing lines most closely approaching it in the character of service. The closest parallels available of which we are aware are the Manhattan Elevated system and the Chicago elevated roads. The Rapid Transit road will have the advantage of a much more concentrated traffic to draw upon than the Chicago roads. It will have the advantage over the Manhattan Elevated in its present condition of electric traction instead of steam locomotives. The operating expenses of the Manhattan last year were only 58% of its gross earnings. The operating expenses of all the Chicago elevated roads were 64% of their gross earnings. Of course this is not conclusive argument; but it is evidence worth consideration.

It seems to us that there is more or less fallacy in the common assumption that the cost of carrying a street railway passenger varies directly with the length of his journey. It is true, of course, that a car which makes a given trip and from which people are continually getting on and off will earn much more than the same car when it runs over the route with only through passengers. On the other hand, it is to be borne in mind that the big item in the street railway expense account is the cost of motormen and conductors. Nominally these men are paid by the mile; but actually they are paid in proportion to the time spent. Now if the speed of a car or train is doubled, it is obvious that the car miles or train miles manufactured per hour is also doubled. In other words, the passenger is carried over twice as great a distance at no greater expense for labor on the part of the company.

We believe that this point has been overlooked by some of those who have hazarded the assertion that the express traffic of the Rapid Transit system could not be made to pay, as well as in some of the comparisons of its local lines with the present surface traffic.

We may point out also that both our contemporary's conclusion and our own were based on general considerations merely. The proper way to attack the Rapid Transit problem—and the way we hope it is being attacked by some of the firms who are said to be figuring upon it—is to make an actual estimate in detail of the operating expenses of the road at its start. It should be possible to do this with a very good degree of accuracy and reliability, and in this way definitely settle what the road will have to earn as a minimum at the start to meet its obligations.

The only problem then remaining will be one as to the amount of traffic that can be secured. Concerning this "The Street Railway Journal" says in the same issue from which we have quoted above:

> The city will, during the five-year period allowed the Commission for construction, quite certainly give the additional facilities which it will offer, and the relief from the daily woes of travel which it will afford will be but temporary. The underlying fact which will impress itself upon all who study New York transportation conditions is that in this long, narrow island, upon which a mass of travel surges down in the morning and back at night—this metropolis of America, which is daily getting more and more permanent residents and attracting visitors—the demand for transportation facilities will always and inevitably be far ahead of the possibility, and every means of relieving the congestion will be welcomed.
>
> "And those who came to curse remained to pray."

WHAT SHALL WE DO WITH THE TRUSTS?

There is no question before the public to-day which excites such widespread public interest as the question of the trusts, and none, it may be added, on which a greater amount of misinformation has been spread abroad. It is a many-sided question. The capitalist regards it from one point of view, the politician from another, the mass of workers and consumers from still another. Contradictory opinions bristle from the pages of newspapers and reviews, and are heard in every place of public debate. There is an undoubted public demand for legislative action; but as to what this action should be, or even upon what principles it should be based, there is no unanimity.

It is a common idea that the Trust problem is one that has sprung up in the past year or two. The present agitation and popular interest does indeed date from about the beginning of 1898; but the Trust problem in its broad aspect is far older than this. We are using the word "Trust," of course, in its popular and now generally accepted signification of a combination among a number of competitors to do away with competition, whether by general agreement, or by some form of direct consolidation. The Trust problem is the problem of monopoly—of the restraint of competition in small degree or great, and it is, we believe, the most serious economic question that civilized society has ever been called upon to face.

Ten years ago, one of the editors of this journal undertook a systematic study of the tendency then apparent in a great variety of industries toward "the death of competition." He had been trained in the orthodox school of economics, to the implicit belief that "competition is the life of trade;" but he undertook the investigation wholly without prejudice or partisan bias, with the sole object of finding out the truth concerning modern economic conditions. The chief result of these studies, which were published at the time in a small volume entitled "Monopolies and the People," may be stated in a few words: It is that the tendency toward monopoly—that striving for the suppression of competition which is plainly discernible in almost every branch of industry and of commerce to-day—is a direct outgrowth of the great advancement in all the arts and industries which has signalized this century. The railway and the loom and the blast furnace and all the ten thousand beneficent inventions that have accompanied them have fostered the growth of monopoly, and have in some fields made competition actually impossible, except under conditions which cause more injury than benefit to the public.

These facts were plain to any thorough and impartial student of the problem of monopoly a decade ago; but they are even more easy of recognition now. The principle above laid down has, during the past decade, been widely accepted by economic writers, and it is gradually coming to be understood by the public as well.

It is not too much to say that a general and intelligent understanding of this principle is a necessary precedent to any useful and successful action by state or nation upon the problems which the trust movement presents. The laws of evolution are stronger than any that legislatures can make or courts can enforce. For example, the "Trust" agreements of ten or a dozen years ago (whence the present use of the word Trust arose), were made unlawful by the legislatures of a score of

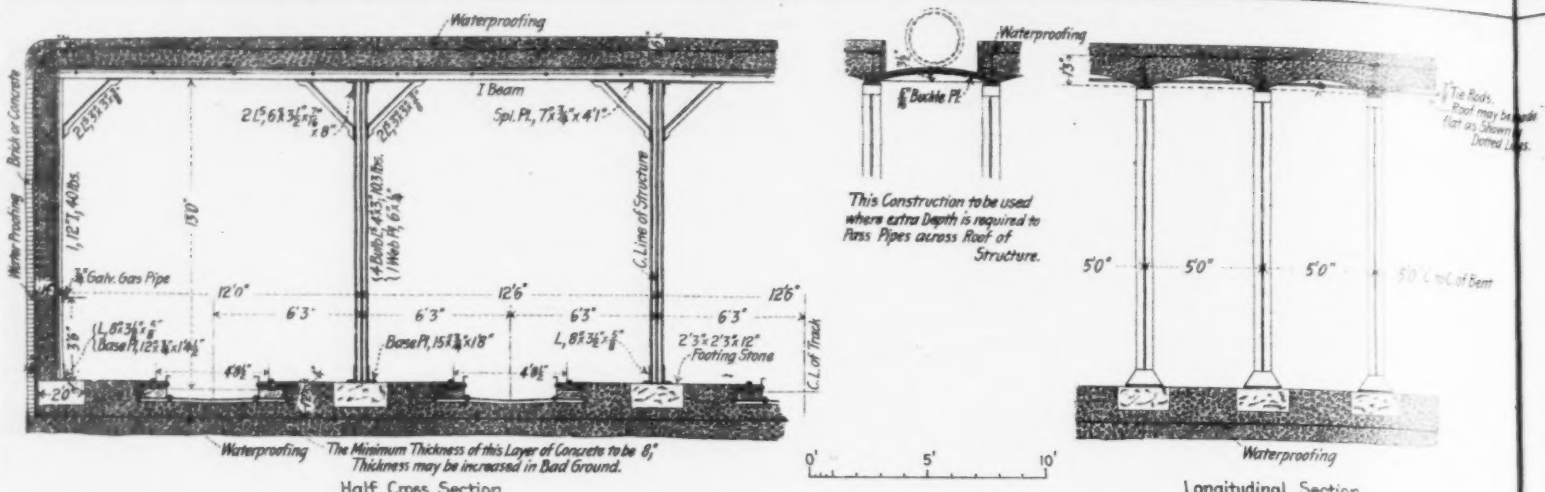


FIG. 2. PLAN AND SECTIONS OF STANDARD FOUR-TRACK SUBWAY CONSTRUCTION.

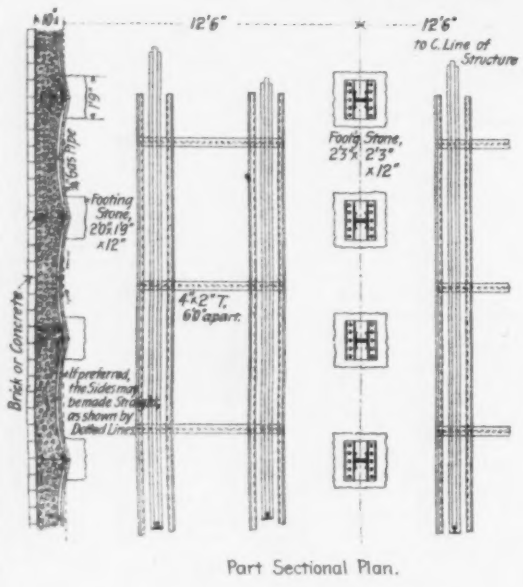


FIG. 3. TRANSVERSE SECTION OF FOUR-TRACK SUBWAY CONSTRUCTION UNDER PARKWAYS.

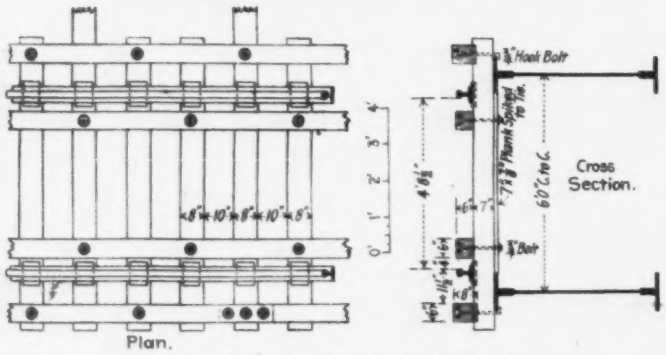


FIG. 13. STANDARD TRACK CONSTRUCTION ON ELEVATED AND VIADUCT LINE.

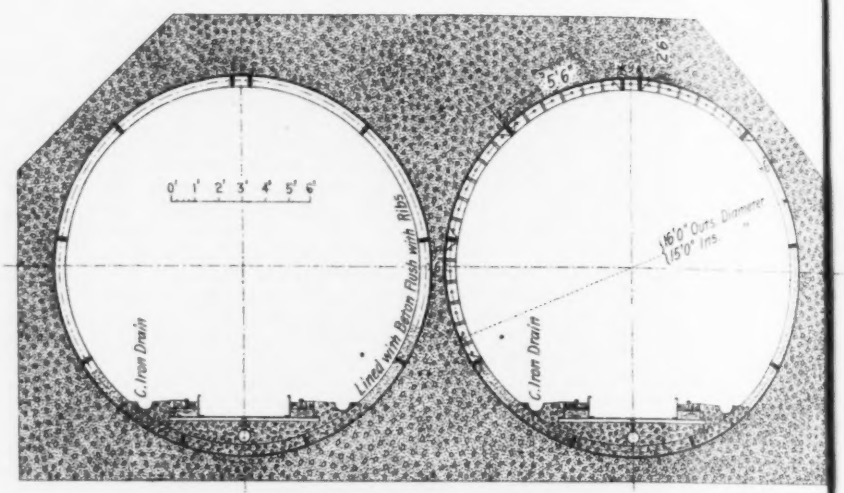


FIG. 10. TRANSVERSE SECTION OF DOUBLE TUNNEL LINE UNDER HARLEM RIVER.

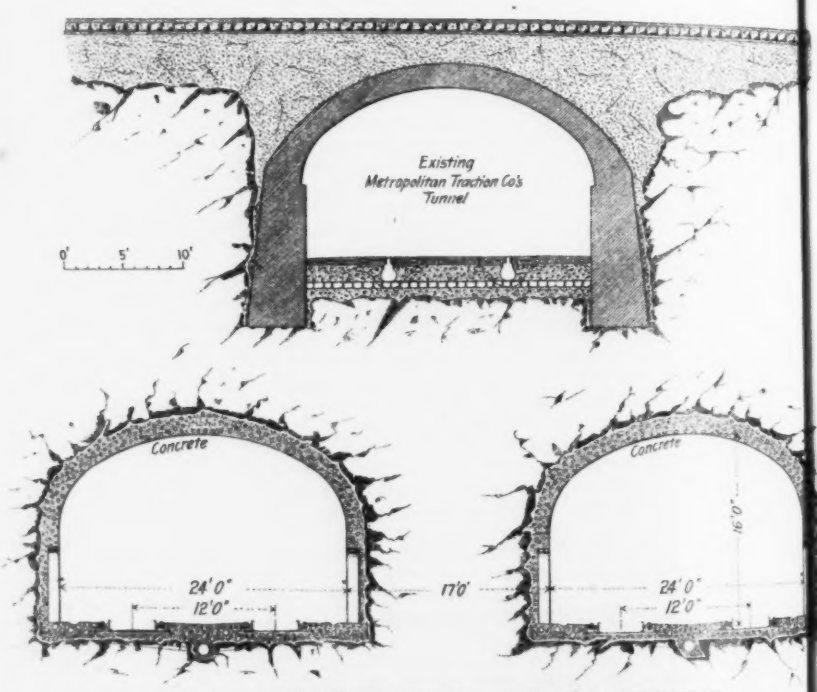


FIG. 7. FOUR-TRACK DOUBLE TUNNEL CONSTRUCTION UNDER PARK AVENUE.

THE NEW YORK RAPID TRANSIT TUNNEL RAILW

William Barclay Parsons, M. Am. Soc

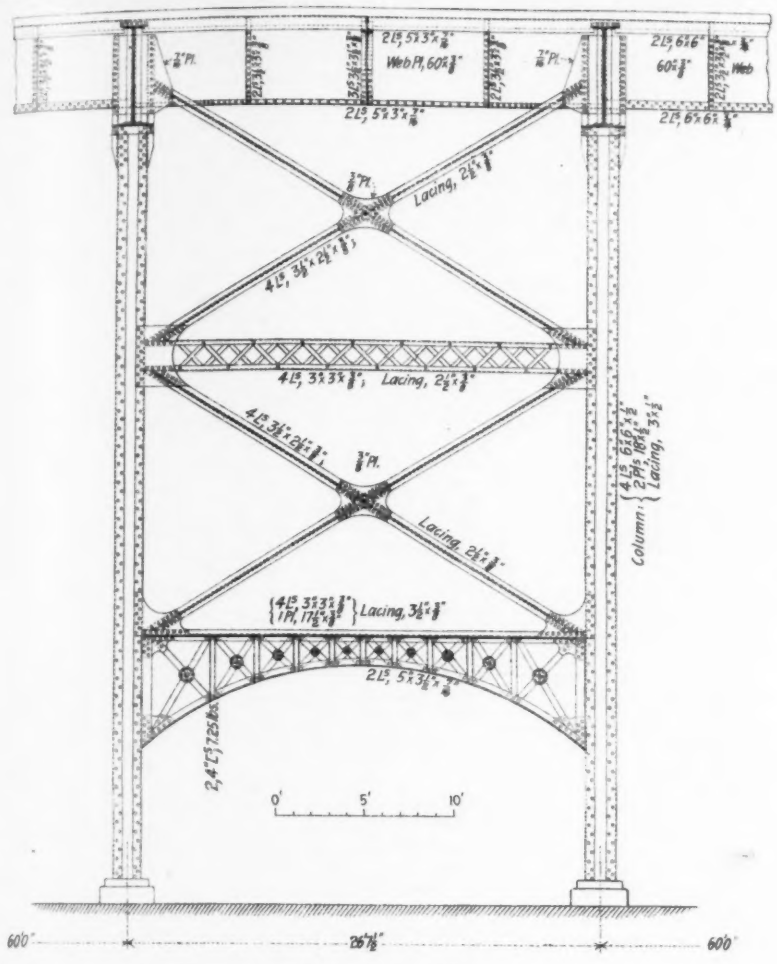


FIG. 12. LONGITUDINAL ELEVATION OF VIADUCT LINE CONSTRUCTION.

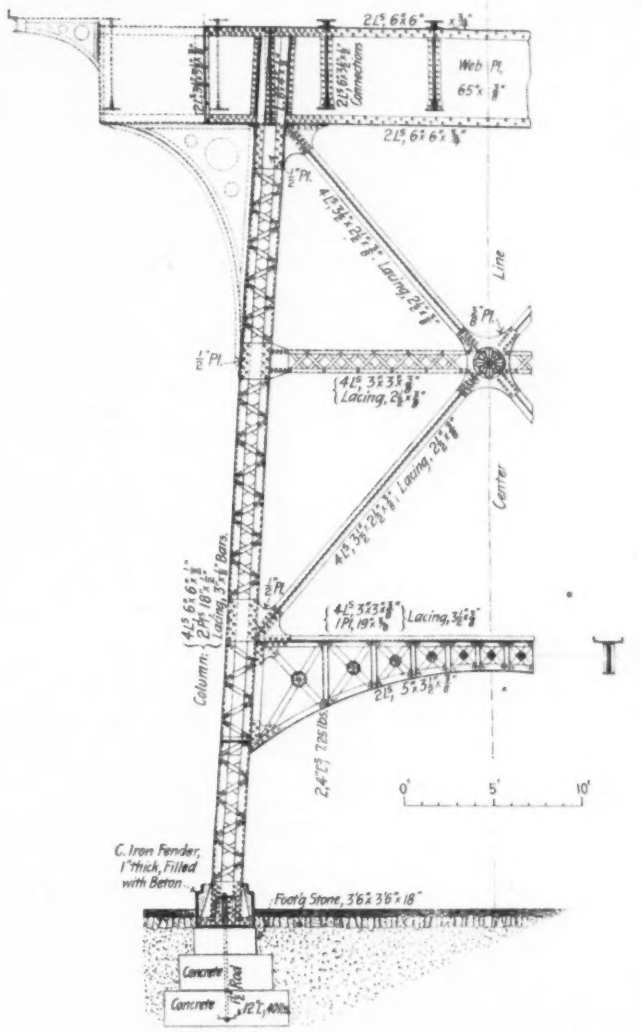
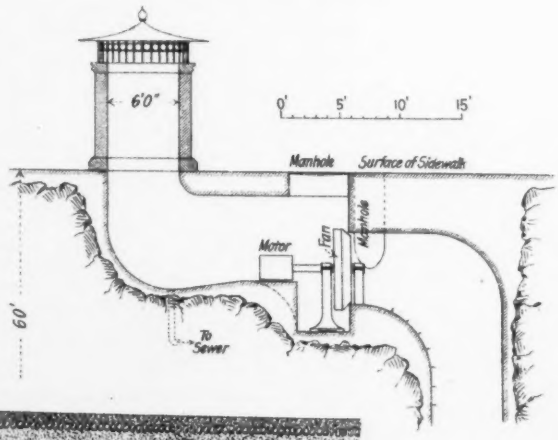


FIG. 11. TRANSVERSE SECTIONAL ELEVATION OF VIADUCT LINE CONSTRUCTION.



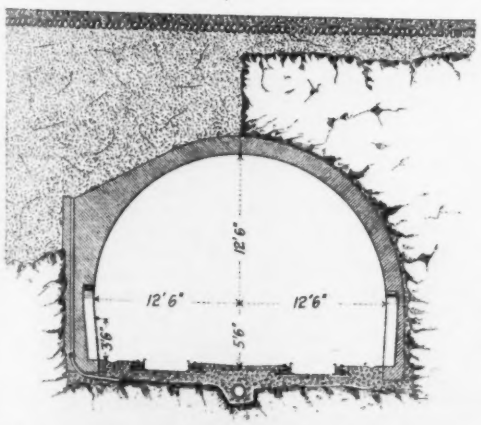


FIG. 8. TRANSVERSE SECTIONS OF DEEP TUNNEL CONSTRUCTION UNDER CENTRAL PARK.

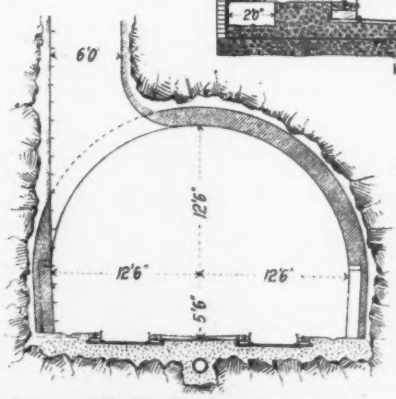


FIG. 9. VENTILATING SHAFT AT 104th ST. FOR CENTRAL PARK TUNNEL.

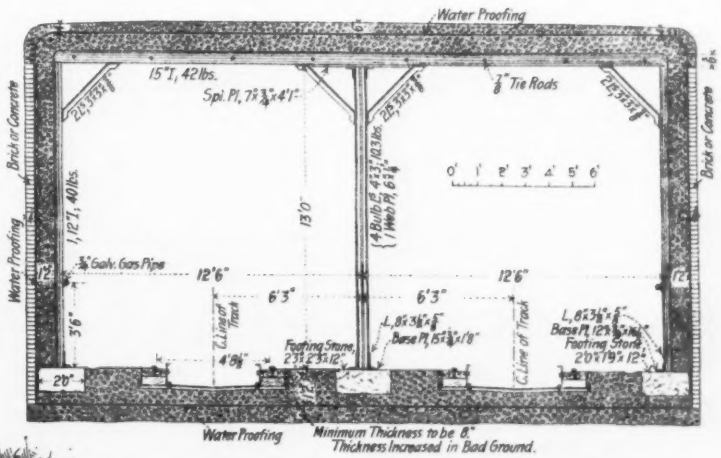


FIG. 6.
TRANSVERSE SECTION
STRUCTURAL DOUBLE TRACK SUBWAY.

TUNNEL RAILWAY. GENERAL STRUCTURAL DETAILS.

sons, M. Am. Soc. C. E., Chief Engineer.

CHAS. HART, LITH., 98 VESEY ST., N. Y.

states and by Congress; but competition was not thereby re-established. The trusts were abolished; but in their place came actual consolidations. "You may lead the pony to the water; but you cannot make him drink," runs the old saying. So lawmakers may take all sorts of measures to foster competition, but they are powerless to force two concerns to actually compete with each other against their will.

A new edition of the book above referred to has just been published,* in which the author has retraced the ground gone over in the original investigation, and has summarized the progress which has been made during the past ten years toward the death of competition in each class of industries. It need hardly be said that the important conclusion enunciated above is fully confirmed. There need be no longer the shadow of a doubt that the trusts are with us to stay. The factory system of production, the railway, the department store—these and a hundred other outgrowths of this century, have created a new economic system, and one in which free competition, the panacea of the old school of political economists, can no longer apply. It follows from this that the policy of repression cannot solve the trust problem. Statute laws can no more create anew the days of free and universal competition than they can abolish the railway, the cotton mill and the electric light.

Is it true, then, as certain would-be prophets aver, that the trust problem will solve itself, if let alone, and that it is no business of the state or nation to interfere? This question also has been carefully and impartially investigated.

There is a deep-seated reason for the instinctive enmity with which the public regards the progress of every movement for the suppression of competition. In the last analysis, competition is the force which makes for an equitable distribution of the products of industry. The inventions and developments in the mechanic arts during the century just closing, have multiplied over and over again the wealth-producing power of the world's workers; but the distribution of this wealth so that all classes may receive their fair share of the product is a problem of increasing difficulty.

Under the old system of free competition, prices were regulated by the law of supply and demand. When there is only one source of supply, however, those who control it can fix prices to suit their own pleasure, and can base them on "what the traffic will bear," to use the common phrase. In this way they may receive a compensation far greater than that to which they are equitably entitled. It is evident that every man's income depends in the first place on the prices which he receives for his labor, his skill or his capital; and in the second place, when measured in the terms of the products of industry, it depends on the prices he is obliged to pay for these products. Clearly then, the disappearance of competition in many branches of industry is a matter of deep concern to every man. Freedom and independence are sacred words to Americans; but economic freedom and economic independence of the individual cannot exist if monopolies are allowed to carry on their operations without hindrance and tax the public at their pleasure.

Evidently, the only agency which has the power to intervene to prevent this is the government; and it is now clearly established in all civilized countries, that in every case where the existence of a monopoly is proved, it is both the right and the duty of the government to intervene, either for the suppression of the monopoly or for its supervision and control.

This policy has been opposed at every step; yet it has been and is being adopted in greater and greater degree, not from choice, but from sheer necessity. There are very few now who contradict the assertion that the so-called "natural monopolies," the railways, telegraph and telephone lines, and all those agencies which control arteries of distribution in city streets, are in all respects subject to direct governmental control. This is admitted, and is in fact a well-established principle of law. The main ground of contention in this field is whether it is wiser public policy for the state or city to own or operate these monopolies itself, or to confer the privilege upon a private corporation, subject to such terms and restrictions as may be made.

It appears to us that the same principle which has been so fully established with regard to these natural monopolies holds good with the trusts. Whenever and wherever a monopoly is created in any industry through which the public loses the protection which free competition affords, the right and duty of the state to interfere is clear. What the degree of this interference should be, must be decided for each particular case by itself. No one but an abstract theorist lays down one rule to fit all cases. The followers of Herbert Spencer, who would abolish the public school and the post-office, are just as wrong as the extreme socialists, who advocate state ownership and management of all manufacturing and commerce. We shall have to feel our way in these matters; but on the whole there is more danger of moving too slowly than too fast.

Let us now recapitulate the principles above laid down. They are, first, that the tendency toward monopoly is a natural evolution from modern industrial progress, and one which is bound to grow with the further development of invention and industry. Second, that it is the right and duty of the commonwealth to protect its citizens from extortion, and that it should do this by the restriction and control of monopolies in such manner as may be most expedient.

These are simple principles; but their general understanding and acceptance must precede any intelligent public action toward the solution of the trust problem. Signs are not wanting, however, that public education in this direction is proceeding at a rapid rate. There will for years remain a minority who will cling to the precepts of the old "laissez faire" school of economists, failing to understand that the old-time precept: "that government is best which governs least" was enunciated in a different world from that in which we live to-day. But this class of men cannot stop the progress of evolution. Even when they get the upper hand in politics, they will find the logic of necessity too strong for their theories, and be forced to adopt just such measures as they have in principle opposed.

And now let us ask what measures are open to the state for the control of trusts and other monopolies. This question has also been discussed at length in the work above referred to. At present the plan in almost universal use, where state control of industry has been adopted, is to place the task of supervision in the hands of public officials, or commissions, appointed or elected for that particular work. Thus we have railway commissions, state and national, gas commissions, electric light commissions, state insurance departments, national supervision of national banks, national supervision of steam vessels on navigable waters, and many other examples that might be named.

This plan of control has worked well in many instances. In others the task which the commission has attempted to perform have transcended its powers. The Interstate Commerce Commission, for example, finds that in order to remedy the abuses which are brought before it, it must have power to compel obedience to its decisions. To this the reply is made that the grant of such power would practically enable the commission to fix the rates that railways shall charge; and it is truly said that to empower five men at Washington to fix railway rates for the whole United States would be so far beyond their physical powers as to be absurd. It has become fairly clear that if state or nation are to interfere at all in the establishment of railway rates (and the necessity for such interference has already been shown), means must be provided proportionate to the task in hand.

Again, the control over gas and electric light companies by a state commission in Massachusetts has worked well in some respects; and in others it has demonstrated the inability of such a body to take any very radical steps for the reform of well-known abuses. In the matter of the trusts: if it should be decided to subject them to government control to prevent the evils of discrimination, oppression of their employees, and exorbitant charges to the public for their products, in what form can that control be exercised without transgression of the rights of the trust owners, but with effective protection of the public?

The author's answer to this question in the book above referred to is a somewhat radical one; but it is a solution for which the way is rapidly being paved. He holds that the time has come when the state must control some of these great monopolies, not from the outside through a commission, but from the inside through direct representation upon the Board of Directors of the corporations which have secured these vast powers.

The legal right of the state or the nation to do this seems entirely clear. A corporation is an artificial person, created by process of law, and subject in every respect to the restrictions and regulations of the power that created it. We have engaged in a great experiment in permitting the unlimited formation of corporations to conduct business of any and every sort. The experiment has brought large benefits, but it has brought serious evils as well. It is entirely within the power of the state to take steps for the reform of these evils by the imposition of any and every restriction upon corporations that may seem best.

It is admitted on all hands that the trusts and all monopolies have duties to the public. Their managers are as much bound to observe these duties a they are to protect the interests of their own stockholders. Then why should not the public have a direct voice in the management? It would not be a difficult matter to cite cases where the voice of the government directors in a trust's management might be to the direct advantage of the stockholders of the trust, as well as a benefit to the public.

It is of interest to note that since the publication of this proposal in the volume above cited, financiers prominent in the administration of some of the largest trusts have given public approval to this plan, and expressed their willingness to accept national control in such a form.

The question may be raised whether such regulation would be a constitutional procedure; but the proper answer to this is, that in the present temper of the public, little difficulty should be found in making it so. The Supreme Court in its recent decision in the Pipe Trust case has drawn a hair-splitting decision to the effect that "manufacture" is not "commerce" and that Congress, therefore, had no power to interfere with the combinations by which the Sugar Trust was created, while it had power, through the Anti-Trust law, to prohibit the combination made by the manufacturers of cast-iron pipe. All such obstacles to government regulation may be avoided by the passage of a constitutional amendment giving Congress the sole power to charter and to regulate all corporations doing business outside the limits of a single state. A national incorporation law is as much needed as was the national bankruptcy law. Already in the present session of Congress an amendment has been presented having this end in view. Both political parties are fully committed to action of some sort for the protection of the people from monopolies. It needs only wise and intelligent leadership to see some real progress made toward the solution of the question at the present session of Congress.

We are well aware that the familiar answer to every proposal made for greater control by governments, municipal, state or national, over the monopolies within their borders is that government officials are too corrupt, untrustworthy and incompetent to undertake such responsibilities. We cannot have municipal ownership, it is said, because the city officials cannot be trusted to honestly and efficiently manage water-works or street railways or lighting plants. Municipal control is objected to because dishonest officials make use of such control for purposes of blackmail. Government railway regulation is opposed at every step, on the plea that it will be used to benefit the pockets of office-holders. The proposition to control monopolistic corporations through the agency of government directors will be met with the objection that such directors would be bought up and made to serve the interests of the corporation instead of the public.

*Reviewed on page 390 of this issue.

These are objections that deserve to be fairly met; but the proper way to meet them is to look the situation squarely in the face. Let us fully realize the fact that the public must trust somebody. All these great industries must be carried on by men to whom must be granted powers greater than those possessed by many a prince of feudal days. We have gone far past the days of individual ownership and control of the great industries of modern life. Our railway presidents and managers, the men in charge of the great manufacturing consolidations, and many other like captains of industry do not own the properties in their charge. They are simply trustees for the actual owners.

The whole edifice of modern industry and commerce has for its corner-stone fidelity to trusts reposed. Without this every wheel would stop. It ought to be as easy to find honest trustees to protect public interests as private. It is a fact that the public has a greater interest in the management of many monopolies than their owners. Stop all railway communication with some of our large cities, and hunger and starvation would soon follow; but the railway stockholders would only have to forego their dividends. Raise freight rates on the railway outlet of a manufacturing town, and industries may be ruined and grass will grow in the streets. The money that goes into the pockets of trust-owners through the charge of exorbitant prices has to come out of the pockets of the thousands of consumers.

Is it not time that the public interest was represented in the management of the great monopolies of modern times? Of course such an administration will not be perfect. Few things of man's artifice are. Scandals and corruption will appear, just as they appear in the present system of corporation management. There is no reason to believe, however, that the conditions would be in any way worse than they are at the present time; and just in proportion as the people are roused to the greater responsibilities which are placed upon the government—as they feel that their welfare is more intimately associated with the prevalence of honest men and honest methods in politics—in that degree will large and permanent benefits be gained.

LETTERS TO THE EDITOR.

Records of Deep Borings for the New York State Geological Survey; Correction.

Sir: An editorial note in your last issue, commenting upon a request for information in another column of the same number, incorrectly refers to me as Assistant State Geologist. I wish to say that I have no claim to this title, being merely one of several assistants employed on geological work by the State Geologist. The error probably arose from your considering that the titles employed on the Geological Survey were entirely analogous to those used on railroad work. Very respectfully,

E. C. Eckel, C. E.,
Assistant, Geological Survey, New York.

An English Predecessor of the Centrifugal Railway.

Sir: Referring to the illustration and description of a "Centrifugal Railway" in your issue of Nov. 9, it may be interesting to know that a pleasure (?) railway on this plan was in operation in a public garden at Liverpool in the summer of 1859. I witnessed many people patronize it and would have done so myself but for parental restraint.

To the best of my recollection, the upright zone around which the cars ran was 16 ft. in diameter; the passengers and cars were wholly dependent upon centrifugal force for their stability; many of the passengers were women, and some of them looked quite pale after their experience. The approach to the circle had about half the grade represented in the engraving published in your journal. Yours very truly, S. Prentiss Smith.

The Bank of California San Francisco, Dec., 1899.

Stiffening Thin Steel Pipes of Large Diameter.

Sir: Referring to the communication from Mr. H. J. M., of Dayton, Ohio, in your paper, in regard to a 66-in. steel pipe, ¾-in. thick, and means for protecting the same from collapsing, due to a superimposed load of river gravel, I beg to hand you herewith a drawing of a 16-ft. steel tank, ⅜-in. thick, recently designed by me, which, as you will notice, is provided with means for resisting a collapsing pressure on the upper side. While this case is not identical with the one which your correspondent describes, yet it may offer a good suggestion for overcoming the difficulties to which he refers. I am, sir,

Yours very truly, A. S. Berquist.

Bennett Bldg., Nassau and Fulton Sts., New York city, Dec. 8, 1899.

(The drawing sent shows a central angle iron strut extending from top to bottom of the tank inside, and carrying a small plate at its center. From this plate tie rods radiate to the sides of the tank, provided with turnbuckles for adjustment. While this stiffening is suited to a tank, it would hardly be feasible in a pipe through which a current of any considerable velocity was passing. —Ed.)

Gravel vs. Broken Stone Concrete.

Sir: In your issue of Nov. 9 there appears a letter by Prof. Ira O. Baker, on Gravel vs. Broken Stone Concrete. We have made some tests of compressive strength of Portland cement concrete, along this line, which may prove of interest. These tests were made on 12-in. cubes at the age of 28 days. The proportions of the materials used in making the concrete were: One part of Portland cement to three parts washed gravel, or to 4½ parts of a hard crushed limestone in the first case, of a soft limestone in the second case, and of what we call washed gravel in the third case. The gravel used in the mortar is composed of something over two-thirds clean sand and the balance pebbles. The hard limestone is from quarries near Hawthorne, Ill., the particles of which are angular and sharp. The soft limestone is from near Anamosa, Ia., and is quite soft. The material that we designate washed gravel consists of hard, smooth pebbles from the size of a hazel-nut to 2 ins. in diameter, left after washing the sand from gravel obtained at Spaulding, Ill. The compressive strength given is the average obtained from the breaking of three cubes in each case.

The compressive strength of the hard limestone concrete is 183,180 lbs.; that of the soft limestone concrete is 168,580 lbs., and that of the washed gravel concrete is 150,890. These tests would indicate that the concrete made from the rounded stones, of which the washed gravel consists, is not as strong as that made of the angular fragments of either the hard or the soft broken limestone.

Yours truly, W. A. Rogers,
Engineer Permanent Construction,
Chicago, Milwaukee & St. Paul Ry.

Chicago, Ill., Nov. 20, 1899.

Black Print Processes for Copying Drawings.

Sir: In your issue of Dec. 7 you quote, "from a forthcoming pamphlet" by Mr. Herman Esser, a statement to the effect that "there are at present three different processes in actual use for copying drawings by the aid of the sunlight," viz.: the blue process, giving white lines on a blue ground; the nigrosine or positive black process, giving neat black lines on a white ground, and the maduro or brown process, giving white lines on a dark brown ground. The author states that "all other processes are either too cumbersome in their manipulation, or need dark rooms and other appliances, so that they cannot come into general use with architects, engineers and draftsmen."

The author is evidently unaware of the existence of my black line process, samples of which I enclose herewith, which needs no dark room, which requires less time than either of the three processes named by the author, and which can readily be learned and operated by any fairly intelligent boy.

As you are doubtless familiar with the results of the nigrosine process, you will at once recognize the superiority of the enclosed samples, as to blackness of line, whiteness of ground and character of paper. Owing to the necessary sizing of the nigrosine paper, I am compelled to dissent from the author's statement that "nigrosine prints can be colored, shaded, altered, etc., just like an original drawing"; whereas you can readily satisfy yourself, by trial, that this holds good respecting my prints.

I must also take exception to the author's statement of the time required for the several operations of the nigrosine process, viz.: exposure, 3 to 5 minutes; developing, 1 to 2 minutes; water bath, about 30 minutes. My experience gives results about as follows:

Time in minutes required for:

	Nigrosine process.	Le Clere process.
Exposure	10 to 20	¼ to 1¼
Developing	2 to 10	10 to 15
Bath	30 to 60	1 to 2
Total	42 to 90	say 12 to 20

Yours respectfully, Francis Le Clere, Manager.

21 No. 13th St., Philadelphia, Pa., Dec. 8, 1899.

(The samples of black prints referred to are excellent. If the process by which they are produced is adopted for use in ordinary drafting rooms, it deserves to be more widely known.—Ed.)

Concerning One Sort of Trade Journalism.

Sir: I desire to call your attention to a paper known as the "Southern Review of Commerce," published in Louisville, Ky. I send you under separate cover their issue of Oct. 18, which they have just sent to me, and I call your attention to a series of so-called "editorials" published in this issue, endorsing the various manufacturers of machinery and other products.

On the first page they endorse the Keystone driller, manufactured by the Keystone Drill Co., of Beaver Falls, Pa., as "unquestionably superior to any other made." They also endorse the electric motor trucks of the Dorner Truck & Manufacturing Co., of Cleveland, Ohio, as "superior to those manufactured by any other concern." They endorse in paper machinery the vacuum wet machine manufactured by the Union Machine Co., of Fitchburg, Mass. In river vessel machinery they endorse the Frisbie Engine & Machine Co., of Cincinnati, Ohio. In boiler rivets they endorse those of Messrs. J. H. Sternberg & Son, of Reading, Pa. They then go on to the subject of horseshoes, and endorse the Phoenix Horseshoe Co. For the manufacture of bricks they endorse the machinery of C. W. Raymond & Co., of Dayton, O. Then they go on to groceries, and endorse Kirk's White Cloud Soap, manufactured by J. S. Kirk & Co., of Chicago. Continuing along the same lines, they endorse concerns interested in the following lines: Roofing slate, emery wheels, carriage wheels, gloves, micrometers, boilers, stoves, pianos, belting, paints, hams, rolling mill rolls, draperies, pumps, knives, etc.

Their whole paper seems to be devoted to this special line of news or information, or whatever they call it.

You will note their small editorial in the middle of the paper (the pages are not numbered) on the question of their policy, and I will call your attention to the statement which they make in connection with almost every article, in regard to the method of obtaining the information upon which they base their endorsement of the various concerns. Under the heading, "The Best in Boilers," toward the middle of the paper, and in the second column, I find this statement:

We have never made an unreliable endorsement, and we never will, because we are too careful in our preparation of evidence and fortify ourselves with facts before we make a recommendation.

Now, as a matter of fact, we have had some little experience ourselves in the way that these people conduct their investigations. They recently sent us an "editorial" which they proposed to publish, endorsing us as the most reliable and satisfactory manufacturers of sugar cane machinery in the country. In their editorial they described our machinery, gave lists of several contracts which we had received, and then went on to plaster us all over with a catalogue of compliments similar to those which appear concerning the other concerns which they endorse in this issue. They asked us to read the editorial and correct it in any points in which it might not be accurate. Now, as a matter of fact, we have never manufactured, and never expect to manufacture, a single dollar's worth of sugar cane machinery, and you can see that their editorial in regard to us was purely guess-work and nothing more. That they had never spent a cent in money or an hour in time in looking up our manufactures is, of course, thoroughly apparent. We wrote them, calling attention to these facts, and of course have not heard from them since.

Now, it strikes me that this method of the "Southern Review of Commerce" is a particularly pernicious one. How it is possible for any reputable journal to single out various manufacturers of material and advertise them beyond all other competitors, without regard to truth or even to common decency, is more than I can comprehend. Certainly to endorse—as they do—one manufacturer above all his competitors would be to antagonize all said competitors. However, this is purely a matter to be determined by the "Southern Review of Commerce" itself and not by me; but it does appear to me that an exposé of their method should me made, because from the experience we ourselves reported above, it is so evident that their sickening endorsements are absolutely without value, and are not the result of investigation such as they claim. Just on what principle they select their victims I, of course, do not know, but I feel that it would be doing the reputable manufacturers of the country a great service if the Engineering News or other well-known papers should investigate the "Southern Review of Commerce," and let the public know what the facts seem to be.

Of course, I do not claim that because of our own experience that every other concern is endorsed with as little care, but each article has the same ear-marks, and I have no idea that any of the articles published has any more real value than the article in question concerning ourselves would have had if it had been published.

I remain, yours truly,
Frank J. Llewellyn,
Vice-President and Chief Engineer.
The Gillette-Herzog Mfg. Co.

Minneapolis, Minn., Nov. 2, 1899.

(We extend our thanks to our correspondent for the copy of the "Southern Review of Commerce." It will be a valuable addition to our "curiosity-drawer." Its title-page bears the heading "Vol.

No. 2," but we find no mention of its name in the newspaper directories. Turning to its editorial page, we find that its editor is R. Franklin Starr. He is rightly named. Nothing short of a celestial body, and one of the first magnitude, could perform such tasks as he appears to have performed. The subject of his leading editorial on hand, and he assures his readers that after investigating "each and all of the larger meat curing concerns in the country" he has fixed on one Cincinnati firm as being "the most responsible meat packers in the United States."

He then turns to the subject of "rolls for rolling mills," and says:

"We have just completed one of our invariably careful and exhaustive investigations, conducted by the aid of our large corps of representatives in various parts of the country, specially trained in their peculiar profession.

The man who penned that is no mere Starr. He is a whole constellation! In imagination, at least he has at his elbow a corps of experts scattered the country over and possessed of well-nigh miraculous abilities. These, under the guidance of his single eye, weigh and measure and test and investigate and arrive with infallible precision at the conclusion that one particular manufacturer in each line investigated is superior to all his competitors, or, to use the editor's own phrase, "the best on earth."

We are lost in admiration of the consummate abilities of these geniuses, who are equally at home in testing the merits of coffins and soap, brick machines and dolls, gloves, horseshoes and pianos, bed-springs and paper mill machinery. As for the master mind who collects and sifts the work of all these Starrs of lesser magnitude, and finally announces to a waiting world the final infallible result—words fail us to estimate properly his transcendent abilities.

We have humbly to confess that this sort of trade journalism is not in our line. We may have some idea as to the qualities of ham, when it is well-cooked and served; but it is a far cry from that to putting one's finger on the ham maker par excellence of these United States. We have no experience in coffins, and do not want any. Similar confessions we must make concerning most of the other industries in which the editor of the journal above referred to is such a passed master; nor can we stop here. Even in the fields in which our study and experience have been sufficient for us to claim some expert knowledge, we must humbly confess our inability to select, even as the result of long and thorough examination, any one manufacturer in any line as being in advance of all his competitors.

In view of the information in Mr. Llwellyn's letter printed above, we took pains to make inquiry of a number of the firms who were lauded in the pages of the "Southern Review of Commerce," as to their dealings with that journal. All of them were reputable concerns of good standing, and we received prompt and frank replies. Some of them acknowledged that they had paid a small sum for the publication of the article commending them and their goods. In other case copies were purchased of the paper containing the article. In only one case did it appear that an actual visit to the works had been made by a representative of the paper prior to the publication of the article. It most cases, similar tactics were pursued to those described by Mr. Llewellyn. An article was written up, probably, from information contained in some stray copy of the firm's catalogue, and a proof was sent to the firm. Sometimes some payment was received, sometimes not. In the long run, however, enough was probably received to make both ends meet and keep the wolf from the door. Almost without exception, those who replied to us expressed their disapproval of the methods of the "Southern Review of Commerce," and their regret that their names had been in anyway connected with it.

Notwithstanding the "Vol. XIX., No. 2," on its first page, other information in our possession indicates that the journal is of very recent establishment, at least under its present management. We fear, too, that it is likely to meet an early grave. After it has selected and heralded to the world the best firm in each line of industry, there will be no more work for it to do. Possibly it will begin all over again on its round of investigations and pick out an entirely new set of firms; but such a course would involve a confession of fallibility which seems hardly possible.—Ed.)

FREE CEMENT TESTING FOR MUNICIPALITIES AT THE NEW YORK STATE CEMENT TESTING LABORATORY.

An innovation of great value to city engineers is proposed by Mr. Edward A. Bond, State Engineer and Surveyor of New York, who offers to test free of charge, at the laboratory of the State Engineer, at Albany, N. Y., all cement to be used on municipal public works in the State of New York. These tests will be made for any city engineer or other municipal official in charge of public works upon receiving properly marked and packed samples complying with the following directions:

(1.) Samples should be taken from different packages of the lot, say from one barrel or bag in every ten. Each sample should be taken with a long sampling iron reaching to the center of the barrel or bag.

(2.) The quantity of each sample should be at least 8 ozs., or enough to fill a cubical tin box measuring 3 ins. on each edge. The samples should preferably be put in such boxes, or each may be put in a bag of tough paper, securely tied.

(3.) The several small boxes or bags should each be plainly numbered, and marked with date, and place and name of structure and name and address of official to whom report is to be sent. They should then be enclosed in a tight box and sent by express, with express charges prepaid, to Edward A. Bond, State Engineer, Albany, N. Y., with a separate letter stating that such samples have been sent. Each barrel or bag from which each sample is taken should also be numbered to agree with the sample-numbers.

(4.) The name of the maker of the cement, or its trademark or brand, may be given or omitted as preferred.

(5.) The samples will be tested for fineness, for tensile strength, for time of setting and for checking, and will also be subjected to hot water test if desired. In the tests, the rules of the American Society of Civil Engineers will be followed.

(6.) Samples should be taken and sent at least two weeks before the time when it is desired to receive report of the result of the tests, in order to allow for time in transit, length of test, and mailing of reports of results.

NOTES FROM THE ENGINEERING SCHOOLS.

Worcester Polytechnic Institute.—The following changes have recently been made in the faculty: Professor Guest, head of the mechanical engineering department, has resigned and returned to England; Professor White, head of the civil engineering department, has resigned, being replaced by Professor A. W. French, a graduate from and instructor in Dartmouth; the position left vacant by the resignation of Professor Guest has been filled by Professor Kingsbury, a graduate of the New Hampshire College; the place of Professor Kimball, who died last year, has been taken by Professor A. W. Duff, a graduate of Purdue; Professor Forrest R. Jones, of the University of Wisconsin, takes the place of Professor Ames, head of the drawing department, who resigned to accept a position with Reed & Prince, of Worcester, Mass.

University of Illinois.—The following are some of the subjects of the theses in the civil engineering department for the current year: "An investigation of the physical properties of sand, broken stone, and gravel, as materials for mortar and concrete, with particular reference to the void spaces;" "The most economical concrete, with particular reference to the relative merits of Portland cement with broken stone, and natural cement with gravel;" "The effect of alternate freezing and thawing on weak natural and Portland cement mortars;" "The crushing and transverse strength of concrete, with particular reference to the ratio of the mortar to the void spaces;" "A discussion of the tests made on the Illinois Central R. R. with the University of Illinois dynamometer car, to determine the resistance on straight track, curves, and grades, and also to determine the head and side resistance due to atmosphere;" "The holding power of anchor bolts when fastened with sulphur, lead, cement, wedges, etc.;" "The flow of water in open ditches, with particular reference to the capacity of dredged drainage ditches."

University of Pennsylvania.—Provost Harrison has announced a gift of $250,000 from a friend of the University for the erection and equipment of a laboratory of physics. The new structure will be located at the corner of 34th and Locust Sts., upon ground recently purchased by the University. It will contain, in addition to class and lecture rooms, special apartments for investigations of heat, light, electricity and magnetism, one or more constant temperature rooms, and a museum, which will show by a series of models the history of the development of physics. The details of construction will not be settled until a thorough investigation of the most complete laboratories of this continent and Europe has been made.

The formal opening of the "Free Museum of Science and Art" will take place on Dec. 20th. This museum is the outgrowth of a movement started by the late Wm. Pepper, M. D. Sufficient money for the building was obtained from the State and by donation. The city gave nine acres of ground for the erection of the building. The architecture is that form which prevailed in the north of Italy from the 12th to the 14th century. The entrance, which is on South St., is beneath a broad stone gateway. A bronze statue of Dr. Pepper has been placed in the grounds, and will soon be unveiled.

University of Michigan.—New machinery to the amount of $1,475 has been secured for the engineering shops. This machinery consists of a Kearney & Trecker milling machine, a 17-in. by 12 ft. Flather lathe with latest improvements, a Landis universal grinding machine for doing work requiring greater accuracy than can be obtained with a lathe, and a National automatic bolt and nut threading machine.

Alexander Dow, late electrical engineer for the city of Detroit, discussed "Meters and Meter Practice in Electric Lighting Stations" at the meeting of the Engineering Society, Nov. 24.

A machine for grinding glass surfaces, lenses and prisms has been added to the equipment of the physical laboratory.

Rensselaer Polytechnic Institute.—Mr. H. de B. Parsons, Consulting Engineer, of 22 William St., New York city, delivered a lecture before the students, Nov. 22. The subject was "The Heating and Ventilation of Buildings." Mr. Hiram F. Mills, Chief Engineer of the proprietors of the Locks and Canals on the Merrimack River, of the class of '56 of the Institute, gave a lecture, Nov. 23, on "The Filtration of Sewage and Water."

Tulane University of Louisiana.—In the tests of the machinery for the drainage of the city of New Orleans soon to be made, the city will be represented by W. H. P. Creighton, Professor of Mechanical Engineering, assisted by Assistant Professors Gregory and Rugan and some 30 students of the mechanical engineering department.

The drainage machinery consists of six Babcock & Wilcox boilers of 375 B. H. P. each, and two of 100 B. H. P.; three Allis cross-compound engines of 1,000 I. HP., one of 500 HP. and two of 100 HP., each with direct-connected three-phase General Elçctric generators of 3,300 volts potential. The electric motors are directly-connected to the vertical shafts that drive the centrifugal pump wheels. Six of these pumps have each a capacity of 250 cu. ft. per second with a 10-ft. lift; two have a capacity of 250 cu. ft. per second, with a 4-ft. lift, while the constant duty or daily flow pump has a capacity of 50 cu. ft., with a 4-ft. lift.

The water will be measured over weirs, a bypass containing a needle dam being used to furnish sufficient water at the required heads.

In dry weather the ordinary power will be about 45 I. HP.; continuous heavy rains will gradually call for more power until finally the whole 4,000 I. HP. may be in use. The station is so arranged that any generator can be thrown on any pump, after being brought up to synchronism with those already in use. In starting the pumps, pits are emptied by auxiliary pumps.

Lewis Institute.—This Chicago institution is now in its third year, and has about 600 students in the day classes and 800 in the night classes. It was founded by Mr. Allen C. Lewis, and is designed to afford higher education to those who have completed the regular school courses and cannot afford the time or money to secure a college education. The scope of instruction is very broad, including engineering (mechanical and electrical), languages, literature, mathematics, drawing, chemistry, photography, domestic economy (and

cooking), etc. The institute building is a six-story brick and stone structure at Madison and Robey Sts., designed specially for its particular purposes, and well-equipped with the necessary apparatus and conveniences. The drawing rooms, blue-printing apparatus and photograph department are on the sixth floor, chemical and physical departments on the fifth, and the other floors have the lecture rooms, class rooms, library, etc. In the basement are the power plant, foundry, forge shop, and engineering laboratory. A separate building has the wood-working shop on the first floor, and the machine shop on the second floor. These are well equipped with tools, and have tool rooms in charge of an attendant. The line shafting is driven by an electric motor. Most of the men and boys in the machine shop are at work during the day, and spend their evenings in thus improving their knowledge and experience. The officers are as follows: President, John A. Roche; Secretary, John McLaren; Director, George N. Carman; Paul M. Chamberlain and Clarence E. De Puy, Associate and Assistant Professors of Mechanical Engineering; Fred. A. Rogers, Instructor in Electrical Engineering.

Massachusetts Institute of Technology.—The Institute, through members of its faculty, is intimately connected with the "Lowell Free Courses." These members of the faculty give lectures on such general or professional subjects as are chosen each year for the series. Courses are offered in literature and language, as well as in science and engineering. Since Nov. 1, for two evenings every week, lectures on steam engineering (from the generation of steam to its use), practical methods of testing steam plants, and discussions on economical practices have been held. Another course deals with descriptive geometry, and in another, demonstrations on the use of electrical measuring instruments are attended by a class. In those on the elements of mechanism, the designing of cams of four-bar linkage, and gear-teeth is being treated. Similar to the work in political economy and industrial history of the students of the Institute is the course on railroad economics and legislation. One of the purely literary courses is that given by the professor of English literature on the "Beginning of English." Later in the season other courses will be announced.

The Institute announces a recent gift of $50,000 from Mr. Augustus Lowell, which, according to the express wish of the donor, is to serve as the nucleus of a fund, the income of which shall be used for the benefit of the teaching staff of the Institute in cases of illness, death or retirement, subject to such regulations as the government may from time to time see fit to adopt.

WATER SUPPLY AND PURIFICATION WORKS AT PARKVILLE AND BETHANY, MO.

By Wynkoop Kiersted, M. Am. Soc. C. E.*

Sedimentation and Mechanical Filtration at Parkville, Mo.

The village of Parkville is situated upon the banks of the Missouri River, about 9 miles north of Kansas City, and is chiefly noted as the home of Park College and Family.

The water-works were designed by the writer, primarily for the college buildings, and were intended to supply a consumption of 100,000 to 150,000 gallons of water per 24 hours. They are being constructed under the direction of Mr. Howard B. McAfee, Business Manager and Treasurer of the Park College Family.

The system of water-works embraces a storage reservoir on a hill 260 ft. above the average stage of the river, a distributing pipe system which affords an ample fire protection to all of the college buildings, a settling basin, filter plant, high and low pressure pumping engines, manufactured by Laidlaw-Dunn-Gordon Co., a clear water well, and a station building of ample capacity for the water-works machinery and an electric light plant. The source of supply is the Missouri River, to which a 10-in. intake extends from the pumping station, the latter being located about one hundred feet from the river. The most interesting feature of the water-works plant is that portion designed for the clarification of the water.

The available ground for the station and water clarification plant was too limited for the construction of a settling basin of sufficient capacity to insure complete clarification of the water by sedimentation alone, since in the near future the village as well as the occupants of the college building will become water consumers. For this reason the design embraces both sedimentation and filtration.

Fig. 1 is a general plan of the settling basin, filters and clear water well. The capacity of the settling basin is about 280,000 gallons. The filters are of the mechanical gravity type, each 8 ft. in diameter, and of a nominal filtering capacity of 100,000 gallons per 24 hours, manufactured by the Jackson Filter Co., of St. Louis. The settling basin is designed for the continuous-flow method of sedimentation, although the water in the basin itself practically comes to a state of rest. Under normal working conditions, the water enters the first basin through the inlet shown in [illegible] deposits its sediment and enters the [illegible] over the weir in the partition wall, which [illegible] long and 0.6 ft. deep. The water then [illegible] the effluent well over the arch wall in [illegible] of the second basin, or through the 8-in. [illegible] into the wall, thence passes through an [illegible] into the filters, and finally enters the [illegible] well. The walls of the basins are of [illegible] from the college grounds, square-jointed [illegible] to 2 natural cement mortar.

In the filter house is located the coagul[illegible] tank. It rests upon the top of the arch buttress [illegible] sufficient elevation to deliver by gravity the [illegible]ation of coagulant into the river water, either as it passes over the weir in the partition wall as it enters the effluent well over the arch wall or through the 8-in. pipe. Thus 24 hours more or less of natural sedimentation precedes coa[illegible]ation, and insures an action of the coagulant [illegible] the fine and light particles of sediment which do not settle naturally within the time usually permissible.

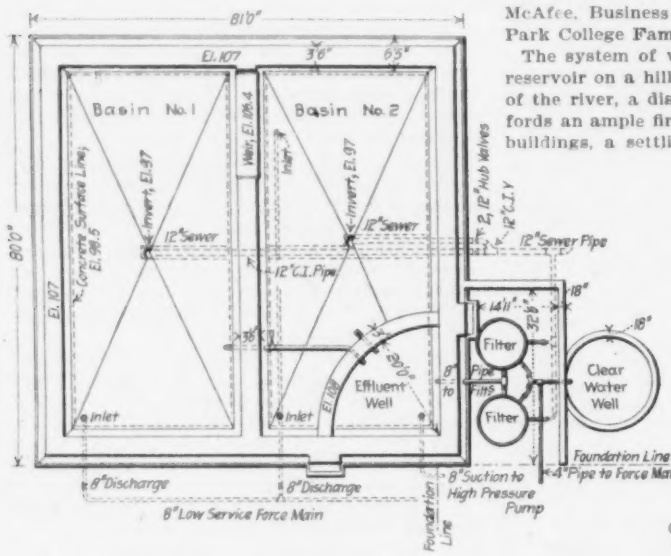


FIG. 1.—PLAN OF SETTLING BASINS AND FILTERS FOR THE WATER-WORKS OF PARKVILLE, MO.

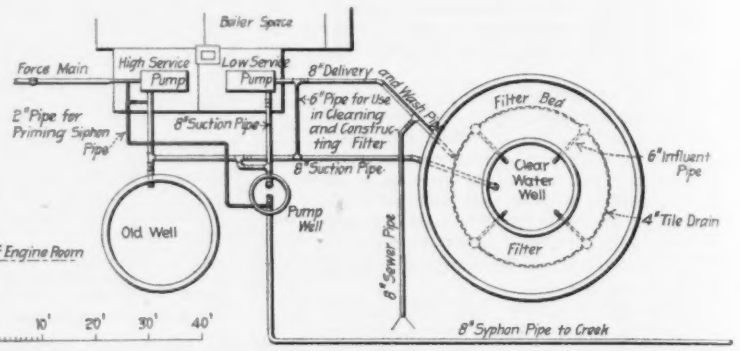


FIG. 3.—PLAN OF PUMPING STATION, FILTER BED AND CLEAR WATER WELL, AT BETHANY, MO.

W. Kiersted, M. Am. Soc. C. E., Engineer.

The coagulation at the weir will clarify the water sufficiently for domestic purposes, at least for a considerable portion of the year, when the basins are worked under normal conditions; but when either basin is being cleaned, filtration must supplement natural settlement and coagulation. In that event the coagulant is introduced at the arch wall as the water enters the effluent well and thoroughly coagulates the sediment before the water reaches the filters.

For a few days in the late fall, the comparatively low temperature of the night air reduces the temperature of the surface water in the basin below that of the river water and causes more or less of an agitation of the water throughout the basin. This action retards clarification by sedimentation to an extent which may not be altogether controlled in the comparatively small settling capacity provided in the basins, except in conjunction with the filters.

The influent pipe to the clear water well discharges near the bottom of this well, which is about 10 ft. deep. When this pipe is free from air a siphon effect is produced upon the filters, depending upon the level of water in the clear water well.

The storage reservoir upon the hill is covered to protect the clarified water from exposure to sunlight and the consequent tendency to the pollution of the water by organic growth during the summer months.

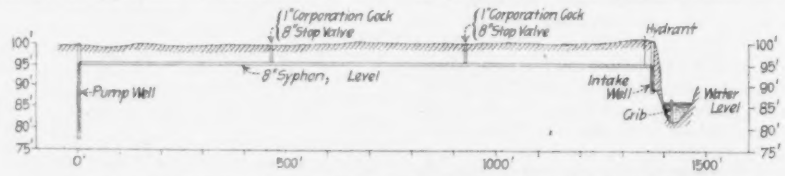


FIG. 2.—PROFILE OF SIPHON-INTAKE FOR THE NEW WATER SUPPLY OF BETHANY, MO.

W. Kiersted, M. Am. Soc. C. E., Engineer.

*Water-Works Building, Kansas City, Mo.

40 ft. in diameter and has a nominal capacity of 150,000 gallons. The enclosing walls are of rubble stone masonry, lined with 9 ins. of brick laid in cement mortar. Upon the top of the wall is a wall plate composed of segments of 2-in. plank anchored by ⅝-in. hook rods built about 2 ft. into the masonry. Radial rafters, 2 × 12 ins., spaced 2 ft. 7 ins. apart at the plate, extend from this wall plate, with about one-third pitch, to a tenoned deck concentric with the axis of the circular enclosing walls, and 9¾ ft. in diameter. Short 2 × 8 in. rafters extend from the deck to the apex of the roof. The rafters are sheathed and shingled, except where ventilators and entrance doors are provided. The bottom of this reservoir is covered with concrete about 9 ins. thick. In short, the storage reservoir is a large cistern covered with a cone-shaped roof.

The plant has been in process of construction for about two years, and will be finished, it is expected, this fall. More or less student labor, together with the tradesmen regularly employed by the manager of the Park College Family were used in the construction, and the exact cost is scarcely obtainable. It was carefully estimated, however, at $20,500.

out the erection and maintenance of an auxiliary pumping station at the proposed new source of water supply, and to clarify the water.

These problems were successfully solved by constructing a siphon to deliver the water from the stream into a pump well at the pumping station, a filter to clarify and purify the raw water, and by installing a low-service pump in an addition to the pumping station to elevate the water from the pump well into the filter. No change was made in the original work about the pumping station.*

Fig. 2 shows the siphon in profile and Fig. 3 is a general plan of the pumping station, old well, the filter and arrangement of new pipe connections.

downtake leg of the siphon. Air is removed through the air cocks at the top of the two vertical legs of the siphon. Upon opening the stop valves in the wells, the siphon action causes the imprisoned air in the unfilled portion of the siphon to rise. It can then be removed by a repetition of the filling process. Another method is to remove the flap of the check valve, to fill the pump well with water from the high pressure main. After having charged the siphon to the valve of the intake well, the valve in the intake well is opened and allows the water from the pump well to escape into the stream, carrying the air with it. The check was introduced simply to avoid recharging

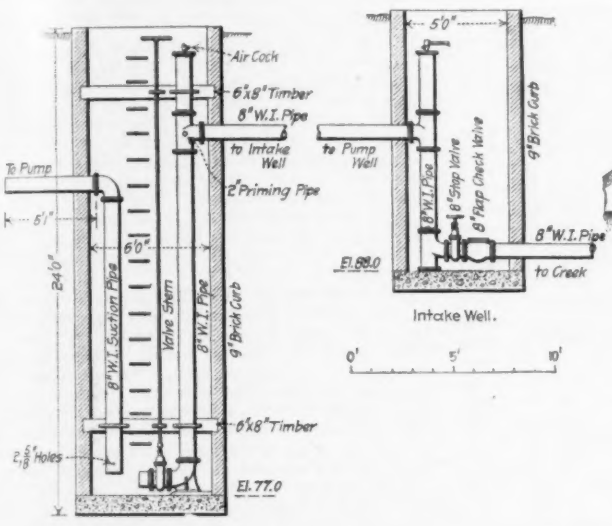


FIG. 4.—INTAKE AND PUMP WELLS AND SIPHON CONNECTION, BETHANY, MO.

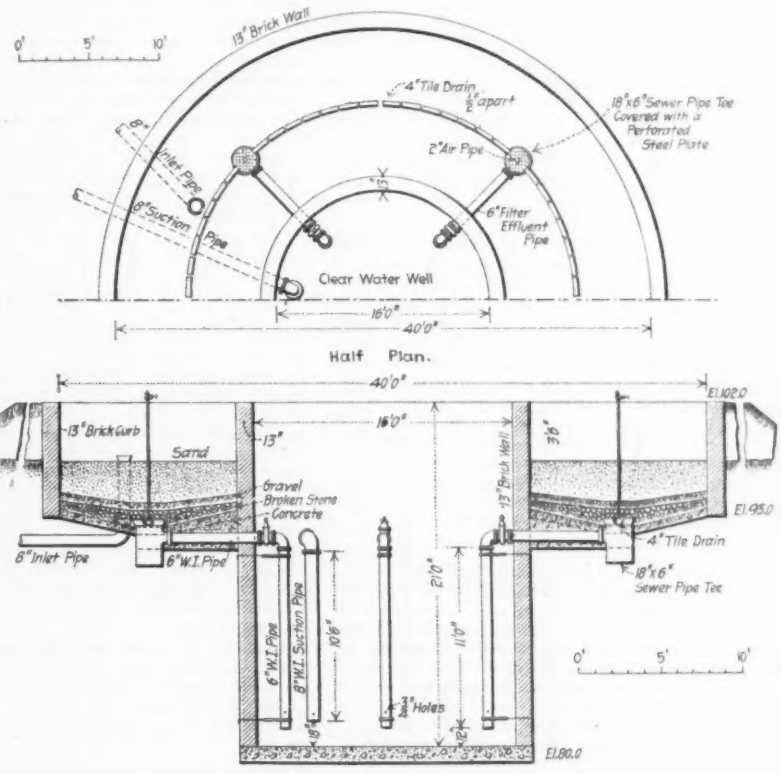


FIG. 5.—PLAN AND SECTION OF FILTER BED AND CLEAR WATER WELL, BETHANY, MO.

New Intake Crib, Siphon, Filter Bed and Clear Water Well at Bethany, Mo.

The water-works at Bethany, Mo., were constructed by the city in 1894. The water supply was developed by sinking an open well into a thin stratum of water-bearing sand adjoining a small stream. The natural bed of this stream is rock, consequently the sub-soils of the valley overlying the rock, through which the stream has its course, are well drained, particularly during the summer months, and cannot afford a permanent water supply of sufficient amount for a town of about 2,000 inhabitants.

The quality of the water was found unsatisfactory because of mineral impregnation, and a few years' operation of the works served to demonstrate most thoroughly the inadequacy of the original water supply. The writer was consulted during the spring of 1898 with a view of remedying the defects. An examination of the locality resulted in a recommendation that the water supply be taken from the stream near which the pumping station is located, but at a point remote from the contaminating influence of the natural drainage from the town site. The point finally selected for abstracting the new water supply from the stream was at a pool formed in a natural depression of the rock bed about 1,400 ft. from the power station. The current of water through the pool, together with an inflow from neighboring springs, seemed to insure freedom from stagnation at all times. The most interesting problems in the work of designing the new water supply was to deliver the water from the stream to the pumping station without disturbing the machinery and pipe connections at the station, and without the erection and maintenance of an auxiliary pumping station at the proposed new source of water supply, and to clarify the water.

These problems were successfully solved by constructing a siphon to deliver the water from the stream into a pump well at the pumping station, a filter to clarify and purify the raw water, and by installing a low-service pump in an addition to the pumping station to elevate the water from the pump well into the filter. No change was made in the original work about the pumping station.*

Fig. 2 shows the siphon in profile and Fig. 3 is a general plan of the pumping station, old well, the filter and arrangement of new pipe connections.

The maximum delivery head of the siphon is about 9 ft. Between the intake and the pump wells, a distance of approximately 1,400 ft., the siphon pipe is of 8-in. cast-iron, laid level upon wooden bearings immediately back of each joint. At two equidistant points are introduced a stop valve and corporation cock for convenience of testing the joints during construction.

The pipes in both the pump and intake well are of wrought iron, with flanged connections, as shown by Fig. 4. Expensive construction below the ground water line between the intake well and the crib in the stream was avoided by constructing the intake well and a considerable portion of the pipe line between it and the crib above water level. The entrance to the crib is made by an abrupt dip with a short length of pipe.

The intake crib is 8 ft. sq. on the outside and 6 ft. high, built up with two walls of 1 × 6-in. boards, the layers at right angles to each other alternating so as to give 1-in. spaces between each layer. The top is covered with 2-in. plank, laid about 1 in. apart. A vertical bolt at each end ties the structure together. It was loaded with stone and sunk without trouble and with little expense.

The air lock between the intake well and the crib is easily overcome in charging the siphon. The stop valves in the wells (Fig. 4) having been closed, high pressure water is admitted from the force main through the 2-in. pipe tapped into the downtake leg of the siphon. Air is removed through the air cocks at the top of the two vertical legs of the siphon. Upon opening the stop valves in the wells, the siphon action causes the imprisoned air in the unfilled portion of the siphon to rise. It can then be removed by a repetition of the filling process. Another method is to remove the flap of the check valve, to fill the pump well with water from the high pressure main. After having charged the siphon to the valve of the intake well, the valve in the intake well is opened and allows the water from the pump well to escape into the stream, carrying the air with it. The check was introduced simply to avoid recharging the siphon should there be a considerable interval of rest between the daily pumping.

The details of the filter are shown by Fig. 5. The only special feature of the filter is the relative arrangement of sand bed, clear water well and the pipe connections, which admits of a head upon the filter due to atmospheric pressure, as well as water pressure, when once the clear water well has been filled and the air removed from the pipe system. By means of the valves upon each of the four filter-effluent pipes, the draft from the filter can be quite readily controlled, although the head upon the filter will vary with a change of elevation of the water in the clear water well.

Small holes are drilled into the filter-effluent pipes and the pump-suction pipe near the bottom in order to break the vacuum gradually, should the water accidentally be drawn too low in the clear water well. The new supply works have been in successful operation for over a year and afford an ample and satisfactory service.

The total cost of the additional supply, including plans, specifications and superintendence, was $4,477, according to a statement by Mr. J. W. Kenyon, chairman of the water committee while the work was in progress.

*Since this article was put in type we have received a letter from Mr. Z. T. Stevens, city engineer of Bethany, in which he states that the siphon, as such, has been abandoned, the pipe being connected directly to the low service pump. He says that at best the water in the pump well could be raised but 6 ft., and that it would soon fall to 2 ft.—Ed.

THE NEW YORK & NEW JERSEY BRIDGE CO. is temporarily enjoined from transferring its holdings to an alleged English syndicate, by Joseph Hendler, a quarry owner, of Wilkes-Barre, Pa. This injunction applies only to the New Jersey end of the project. Mr. Hendler alleges that he contracted to furnish stone for one of the piers of the proposed bridge with the D. E. Culver Co., one of the constructing companies of the bridge, and he estimates that by refusing other contracts while waiting for the bridge work he has lost $15,000, besides $69,550

invested in getting ready for work. He says that he learns that the bridge company has already deposited its stock, franchises, etc., with the Continental Trust Co., as a preliminary to a transfer of property. The counsel for the bridge company denies that any injunction has been obtained against the consolidated company, and that the trouble arises from a complication between the Hendler interest and the New Jersey Co. which does not affect the bridge company proper. It is admitted that a syndicate is trying to obtain control of the project. In this connection it may be noted that the bridge company has again applied to the Sinking Fund Commission for authority to construct an "approach" to the proposed bridge extending from the Battery to 59th St.; it incidentally also asks for permission to build a union railway station on the West Side.

TWO EAST RIVER TUNNELS, or at least an investigation into their feasibility, are contemplated in the appropriation of $75,000 asked for from the Board of Estimate and the Municipal Assembly by Comptroller Coler. The routes would be examined and plans prepared for a tunnel or tunnels, for general traffic, under the East River, from the foot of Whitehall Street, in Manhattan, to the foot of Hamilton Avenue, in Brooklyn, with an extension through South Brooklyn and a tunnel or tunnels to the Borough of Richmond. Another route to be reported upon was from the foot of East 42d St. to the Court House in Long Island city.

THE CITY VS. STATE CONTROL OF LAND UNDER water contiguous to New York city is to be brought to an issue by the opposition of the Corporation Counsel of New York to the late grant of 16½ acres of land under water, in Astoria, to the Astoria Light, Heat & Power Co. Counsel Whalen has requested the Governor not to sign the patent, and it is said will ask the Supreme Court to enjoin the Secretary of State from issuing the patent. It is contended that the city should have control of all lands under water within its limits. The Secretary of State, Mr. McDonough, has held for some time that such lands should be leased by the state for 50 years and not sold at all, believing that in this way the state would retain a valuable source of large eventual income. A bill to this effect failed to pass the Legislature.

A TOPOGRAPHICAL MAP OF GREATER NEW YORK is being made by the Board of Public Improvement for the Paris Exposition. The finished map will be 24 × 28 ft. on a scale of 600 ft. to the inch. It will show all surface contours, streets, piers, ferries, railway lines and all single buildings, and indicate proposed street systems in the several boroughs. It embraces Yonkers, Mt. Vernon and New Rochelle on the north, and Sandy Hook and part of New Jersey on the south; including in all about 1,000 sq. miles of territory. For exhibition purposes it will be mounted on a hardwood inclined platform, 2 ft. high at one end and 3 ft. at the other, with bronze railing, etc. The map will cost about $10,000, and smaller maps forming part of it show the limits of the city in 1641, 1776 and 1800.

THE AUTOMATIC VOTING MACHINE was used in Buffalo and Utica in the late election. As showing its efficiency, as compared with ordinary ballot counting, the Utica "Observer," within 14 minutes after closing the polls, printed and put upon the street an accurate and complete return of an election in a city of over 60,000 inhabitants. The machine cannot be tampered with, or made to "beat itself," without showing indisputably the attempt at fraud; and if it breaks down, the record remains to the point of collapse and a new machine can be substituted. The voter has only to touch the appropriate keys to cast his vote.

U. S. POSTAL RECEIPTS for the last fiscal year aggregated $95,021,384.17; and of this total $87,280,654 came from the sale of stamps, stamped envelopes and wrappers and postal cards. Second-class postage, at pound-rates, amounted to $3,527,032; box-rents, $2,726,558; money order business, $1,286,664, and the remainder from foreign postage balances, fines, dead letters, etc. The actual expenditures amounted to $101,632,160.92. Third Assistant Postmaster General Madden recommends a one-cent rate for drop letters; and again reports on the flagrant abuse of the privilege of forwarding second-class matter, and he recommends a uniform 4-oz. rate to apply to periodical publications, mailed at letter-carrier offices for local delivery. It is noted that New York and Chicago post 35% of all this second-class matter.

BOOK REVIEWS.

THE PRACTICAL STONE-CUTTER AND MASON'S ASSISTANT.—Being a collection of every day examples, showing arches, retaining walls, buttresses, skew-arches, vaults, domes and semi-domes, quoins, groins, etc.; with explanations of the most approved and economical methods of working them out; together with a copious description of the tools used by stone-cutters, showing methods of use, etc. By Fred T. Hodgson, Architect, New York: The Industrial Publication Co. Paper, 10 × 6¾ ins.; pp. 51; illustrated, $0.75.

This little book is not intended as a treatise upon the art of masonry and stone-cutting, but is issued for the purpose of initiating the young apprentice into as much of the rudiments of his art as he can find within its covers, and it may induce him to further study these details. In this respect it is useful; especially, as it rapidly goes over a considerable range of practice, as is indicated in the title.

JIM SKEEVERS' OBJECT LESSONS ON RAILROADING FOR RAILROADERS.—by John A. Hill. New York: American Machinist Press. Cloth; 4 × 10 ins.; pp. 157. $1.

James Skeevers was a young and ambitious, but hard-headed, engine runner on a railway somewhere "Out West," who, by his knowledge of mechanics and human nature, rose peg after peg until he reached the office of Superintendent of Motive Power. The series of sketches of his career which are collected in this book were originally published in "Locomotive Engineering"; but they are written in such an inimitable style that they fully deserve the more permanent form which has now been given them. The quaint and original humor of these sketches, and their faithful portrayal of a type of real life which has seldom been mirrored in literature, make them entertaining reading; and the bits of wisdom, mechanical and unmechanical, which are scattered through the book are not made so obtrusive as to mar the general literary effect.

RAILROAD CURVES AND EARTHWOORK.—By C. Frank Allen, S. B., M. Am. Soc. C. E., Professor of Railroad Engineering in the Massachusetts Institute of Technology. New York: Spon & Chamberlain. Leather; 6½ × 4 ins.; pp. 194; illustrated. $2.

While Mr. Allen originally prepared this material for the use of his students, it is also useful to the majority of practicing engineers; for refreshing their memory, if nothing else. For arrangement and sequence of topic, and for clear and concise mathematical statement, it is unexcelled among field books. The operation of locating a railway line, through the medium of the reconnoissance, preliminary and final survey, is clearly outlined for each; and then follows the discussion of simple, compound and reversed curves, and parabolic curves, including the application of the metric system to railway location. Turnouts, Y-curves and spiral easement curves have each a chapter, with some new treatment in each case; and the operation of setting out stakes for earthwork is described in an unusually full and satisfactory manner. In the computation of earthwork the six principal methods are explained and illustrated, with hints as to their best application under varying conditions. In connection with "haul" the working and special advantages of the so-called "mass-diagram" is explained. Tables of 3-level sections, prismoidal corrections and triangular prisms end the work.

MONOPOLIES AND THE PEOPLE.—By Charles Whiting Baker, C. E., Editor of Engineering News. Third edition, revised and enlarged. New York: G. P. Putnam's Sons. Cloth; 5½ × 7¾ ins.; pp. 368. $1.50.

As customary in reviewing books written by members of the staff of this journal, we confine our review in the present case to a reprint of the preface to the new edition, which is as follows:

In preparing a new edition of this work, ten years after the original was issued, it has seemed best to reprint the older portion of the work substantially in its original form, because, with the exception of a few minor points, the facts which are set forth in Chapters II. to IX. inclusive are as true now as they were when this portion of the book was written, and the discussion of these facts which follows is not only directly applicable to present conditions, but is essential to a clear understanding of the problems which the world-wide movement toward monopoly has created.

To the reader who follows this discussion at the present time, it will be evident that the economic history of the past decade is a complete confirmation of the laws relating to competition, and the forces tending toward its extinction, which the author pointed out in his original discussion.

In Part II. new material has been added, presenting a survey of the growth of monopolies in each of the several departments of industry during the past decade, a growth which has been so enormous as to fix the attention and arouse the fears of the public to a greater extent than has any previous change in industrial or commercial methods. In this review the author has confined his study, with few exceptions, to conditions in the United States. He would point out here, however, that while the movement toward the death of competition all along the line has progressed much farther in this country than in any other, it is a movement world-wide in its extent, and the problems which vex us here are already the subject of discussion in all other civilized countries.

The most important results of the author's study, however, will be found in the three concluding chapters included in Part III. He has here set forth a few of the serious, yet little understood, economic evils with which society is now afflicted, and which are traceable to the disappearance of competition in the evolution of modern industry. Finally, he has outlined a few of the foundation principles which must be followed if society is to put itself in harmony with the situation into which the progress of invention and the evolution of industry has brought it.

Summarized in the fewest possible words, the author's conclusion, now as ten years ago, is that the death of competition in a great proportion of industries is inevitable, and that government regulation is likewise inevitable as the only possible protection of the people against industrial bondage. He holds, however, that this regulation can best be applied, not from the outside, through the representation of the public in the governing bodies of the corporations which own all the great monopolies of the present day. Regulation in this manner may seem at first a [illegible] proposition, it involves no greater interference of government with industrial affairs than is already by law and precedent. What it does promise is to make effectual such measure of government control as may be found necessary, whereas the present method of controlling corporations by legislative enactment, even when aided by commissions empowered to see to the enforcement of the laws, has too often proved ineffectual.

The author is fully aware that great numbers of people are opposed on general principles to anything involving increased interference of the government with industry and commerce. Theories, however, cannot stand in the way of plain necessity. The force of circumstances has already compelled governments everywhere to assume responsibilities that were undreamed of a generation ago. The author's plea is for a frank recognition of the present state of affairs—of the fact that the era of free competition is passing away, and that organized society must provide a substitute to take its place. Let us boldly face these new responsibilities which our government—federal, state, and municipal—must assume. Let us so reform our systems of government that these new responsibilities as well as those already laid upon them may be successfully discharged. Only in this way may we put our industrial system into harmony with modern industrial progress. Only thus may we "pluck the flower, safety, out of the nettle, danger."

THE TWO BOOKS ON THE WATER SUPPLY OF THE CITY OF ROME, of Sextus Julius Frontinus, Water Commissioner of the City of Rome, A. D. 97. A photographic reproduction of the sole original Latin manuscript and its reprint in Latin; also a translation into English and explanatory chapters, by Clemens Herschel, Hydraulic Engineer. Boston: Dana, Estes & Co. Cloth; 8½ × 11½ ins.; pp. 296; many plates and illustrations. $6.50.

In these modern days of rapid change and revolutionary thought, we are apt to hold in light esteem the wisdom of past generations. The lawyer leaves undisturbed the copies of Coke and Blackstone which he purchased in his student days. In the parsonage library the dust lies thick on the works of ancient divines from St. Augustine to Jonathan Edwards. To the engineer, least of all professional men, is the work of his predecessors in by-gone ages of practical importance. Why, then, should any engineer go to great trouble and expense to print at this day, in most elaborate and costly style, the story of the work done by an engineer who lived eighteen hundred years ago?

Such is the question which may perhaps occur to some of those to whose attention this work may come; but the answer is so plain that we hardly need to set it down. To some, at least, and may we not say to everyone imbued with the true professional spirit, "The life is more than meat and the body than raiment." Modern hydraulic engineers may have no use for the masonry aqueducts and curious sheet lead distribution pipes of Frontinus' day, but human nature is the same in all generations. Frontinus' opening sentence, in which he declares that he is "moved not only to devote diligence, but even love to any matter confided to his care," is certainly thought provoking in these days when the need for absolute uprightness and fidelity to trusts on the part of professional men is being more and more realized.

Engineering is often spoken of as a new profession. We have had even conspicuous instances of denial that it is a profession at all. Surely, then, it is a task well worth the doing to unearth the testimony of antique records concerning the lives and works of the earliest engineers.

No engineer who at all deserves the name can view the remains of the great works of the ancients or read such an account of them as Mr. Herschel has here given, without feeling greater pride in belonging to a profession which can claim such antiquity.

The peculiar merit of Mr. Herschel's book is that he has studied Frontinus' writings and the records of his contemporaries from the standpoint of an engineer. He has thus been able to understand things which have puzzled scholars and savants and to detect errors of long standing, in the interpretation of these old-time works. He shows, for example, that instead of the water supply of ancient Rome having been some 275,000,000 gallons per day, as stated by all modern authorities, it was in all probability not more than a seventh of this, or under 40,000,000 gallons. He shows that the old-time aqueducts were exceedingly difficult to keep in repair, and that many of the auxiliary constructions, which have puzzled antiquarians, were in reality makeshift arrangements to stop leaks by putting a patch on the outside, "working against the pressure," as the plumbers say.

Perhaps the greatest charm of the book, however, is the attempt which its writer has made to make the life and times of Frontinus a vivid reality to the reader. We are all too apt, as we read history, to forget that then even more than now, men lived mostly in the present. Frontinus, for example, held the office of Superintendent of the Water Department of Rome, as we should say, about A. D. 100, and we locate him in our minds as a contemporary of Julius Cæsar. Mr. Herschel, by a clever little diagram, however, shows that Frontinus was no nearer in time to the reign of Julius Cæsar than we are to the period of the French and Indian War; and he doubtless knew far less of Cæsar's times than we know of the events of a century and a half ago. As far as future events were concerned, Mr. Herschel shows that Frontinus could have

had no more premonition of the decline and fall of the then mighty Roman empire than we have of what will take place in the year 2122.

Space forbids us to pursue further the pleasant task of selecting bits from the well-arranged feast which the author of this book has set forth. The work is one which should be on the shelves of every engineering school or engineering society library, and it will also find its way, we are sure, to the possession of many engineers who find pleasure in the possession of certain books, not as means to an end, but as an end in themselves.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The first session of the 20th annual meeting of the American Society of Mechanical Engineers was called to order by the President, Admiral Geo. W. Melville, on Tuesday evening, Dec. 5, in the society's house, at 12 W. 31st St., New York city. The evening was devoted to the reading of the President's annual address, which appears elsewhere in this issue, and to the renewing and making of friendships by the attending members.

The Wednesday morning session was begun by a brief business session devoted to the reports of the council, the tellers, and the finance and library committees. The council reported the election of Professor William Cawthorne Unwin to honorary membership, and announced that he had presented to the society copies of his works on "Testing Materials," and "Power Transmission." The council further reported that it had taken action with respect to the increasing number of duplicates which have accumulated in the library, and that, as it seemed advisable to accede to the request of the University of Virginia for aid in securing books to replace the library of that institution, which had been destroyed by fire, they had presented the University with 311 bound volumes of journals, 155 books and other unbound material. The library has acquired by gift the books of the late Horatio Allen and by purchase those of the late W. F. Durfee. The latter will be known as the "Durfee Collection."

The council has also received a very good oil painting of Mr. John Fritz, Past-President of the society, which has been hung in the society's rooms, and, also, a water color drawing bearing the autographic signature of Robert Fulton and showing an aqueduct carrying a canal across a stream upon a lower grade, the plan being to use the fall of the water from the high level canal as a means of towing the canal boats across the chasm. This picture may likewise be now seen upon the walls of the society's rooms.

A report was read concerning the junior's meetings, provided for last year. These meetings have brought out a number of good papers and have been well attended by members and juniors alike.

The council was instructed at the Washington convention to consider the matter of arranging with the American Institute of Electrical Engineers for a joint committee to take up the matter of "Standard Dimensions for Direct-Connected Electrical Generators and Steam Engines." They had appointed a committee to confer, which presented a brief report which will be followed by a full report at the next meeting of the society.

In accordance with a suggestion received from Mr. Albert A. Hopkins, the council had appointed a committee to consider the subject of erecting a suitable monument to Robert Fulton in Trinity churchyard, in New York city. A report was received from this committee through Mr. Gus. Henning, saying that the committee had met with hearty co-operation from the Trinity Corporation and the descendants of Fulton, and that they were ready to receive subscriptions from the members of the society.

The council has received a letter from the Institution of Civil Engineers of Great Britain, inviting the society, in case it should visit Europe during the summer of 1900 as a body, to meet at the house of the Institution. Pursuant to this a circular letter had been despatched to the members of the society in order to learn the number that would probably go. About 500 members had indicated their intention of going and the council had appointed a committee to negotiate with the transportation companies with the object of getting a ship exclusively for the party. As a result, they were able to announce that any one of a number of the ships of the Hamburg-American line were available if immediate action was taken by those members desiring to go on the trip.

The Finance Committee reported the total assets of the society as $81,870.68, and the liabilities as $64,100.00, leaving a balance of $17,770.68. Five per cent. of the members are in arrears.

Report of the Committee on the Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Boiler Trials.

The next matter to come before the meeting was the report of the Committee on Boiler Trials, which, with successive slight amendments, has occupied the attention of the society at the three preceding conventions. The original draft, which has been altered only in minor details, was printed in the issue of Engineering News for Dec. 9, 1897, and as amended, in the issue of Dec. 1, 1898. The report of the committee was accepted without debate.

The Steam Engine at the End of the XIX. Century.

This excellent paper, by Prof. R. H. Thurston, we hope to reprint in part in a future issue. It is a discussion of a test made upon a Nordberg pumping engine, built by the Nordberg Mfg. Co. for the Pennsylvania Water Co., and erected near Pittsburg, Pa. In this engine an attempt is made to approximate the Stirling or "regenerator" cycle by taking steam from the cylinder jackets and leading it into the successive feed-water heaters in such a way that the temperature of the feed-water entering the boiler is nearly that of the boiler. That is, instead of taking mechanical energy from the flywheel, as in the perfect Carnot cycle, to bring the working fluid from the terminal temperature at which heat is rejected back to the initial temperature at which heat is received, heat is taken from the working side of the piston at various stages and transferred to the feed water in the heaters. If this action could be continuous—that is, if the ascending scale of temperature of the feed-water could at all points coincide with the descending scale of the working steam—the cycle would be perfect and would give the maximum possible efficiency when working between given limits of temperature as would the Carnot cycle.

In the actual engine under consideration this action takes place at intervals in the scale. The engine uses quadruple expansion and is supplied with steam at 300 lbs. gage pressure. Steam from the receiver and jacket nearest the boiler is led to the feed-water heater nearest the boiler, and a like action takes place in the three succeeding steps. The efficiency realized in the test was 84% of the maximum possible and 10% better than has ever been obtained before, making this the most efficient engine of the century. A horse power was generated with a consumption of 11,160 B. T. U.'s per hour, or, in other words, 22% of the heat placed in the boiler appeared at the indicators as mechanical energy. The test was reported in Engineering News of May 4, 1899. The paper was discussed by a number of members, notably by Mr. Chas. T. Porter, who objected to the title of the paper, saying that the century had not as yet closed and that he desired that a page or two at the end of the record should be reserved for results which he hoped to be able to accomplish before the end of the century. At the request of the President he described the plans which he has now under way for the construction of a steam engine which should produce a horse power upon 9 lbs. of steam per hour. The plan consists chiefly in the use of high pressures, high ratios of exhaustion, high piston speeds and a system of reheaters by which condensation would be avoided.

The Berthier Method of Coal Calorimetry.

This paper by Mr. C. V. Kerr was the plea for the more extended use of the Berthier method of estimating the heating values of fuels, in which the calorific value of the fuel is deduced from the amount of litharge that it will reduce. Its great utility comes from the fact that it is cheap and easy to employ as compared with the use of the Mahler bomb calorimeter. Hitherto in its use error has arisen from the assumption that all combustibles disengage equal quantities of heat when combining with equal quantities of oxygen. Hydrogen, however, sets free more heat than carbon, but, as it occurs in commercial fuels in relatively small quantities, due allowance can be made according to the nature of the fuel and the results will still be accurate enough for practical purposes. Letting

P = the heating value of a fuel in B. T. U.'s,
L = weight of metallic lead reduced, and
F = the weight of the fuel required to reduce it in the Berthier calorimeter,

we have in the case of pure carbon

$$P = 423.4 \frac{L}{F}.$$

For a fuel containing 2% of hydrogen, as coke, charcoal or anthracite

$$P = 434 \frac{L}{F}.$$

For fuel containing 5% of c[illegible]uminous coal, lignite and wood,

$$P = 450 \frac{L}{F}.$$

Test of Two Pumping Engines at the St. Louis Water-Works.

In this paper Mr. John A. Laird describes tests of the pumping engines at the Baden Pumping Station of the St. Louis Water-Works. The following paragraphs from the paper describe briefly the engines and the results obtained:

The engines tested are duplicates, built by the Edward P. Allis Co., and are of the now well-known type of Reynolds pumping engine which all of the large builders have adopted. They are three-cylinder triple-expansion, condensing, vertical, with rigid connection between plungers and pistons, three single-acting plungers. The diameters of cylinders are respectively, 30, 54, and 80 ins. The plungers are 25½ ins. in diameter, and all are 64-in. stroke. There are two receivers, the heating coils inside of which are helical and extend for the full length of the receivers. The cylinders are jacketed on the sides, but not on the heads. The jackets, cylinder heads, receivers, and all other heated surfaces about the engines are covered with 2 ins. of magnesia and 2 ins. of hair felt; the whole enclosed in walnut lagging.

The distribution of steam through the jackets and receivers is in series from the jacket of the high-pressure cylinder to the first receiver; then to the jacket of the second cylinder and to the next receiver, and so on. This system was designed by Mr. Arthur West, and has the effect of reducing the amount of jacket steam by a small percentage. The steam-distribution valves are all Corliss, except the low-pressure exhaust, which are poppet. The clearance on high-pressure cylinders is 1.036%; on the intermediate, 1.18%, and on the low, .509%.

According to accepted practice on triple-expansion pumping engines, the governor only controls the cut-off on the high-pressure cylinders, the others being regulated by hand. There are two piston rods to each cylinder, packed with Tripp's metallic packing. They connect to an Allis four-cornered cross-head, to the center of which is attached the connecting rod, and to the corners the four pump rods. The piston rods are each 4 ins. in diameter, and pump rods 4½ ins. The pump barrels are directly underneath the steam cylinders, and the valve chambers are on the center line of the engine. The plungers are single acting. The pump valves are 3½ ins. in diameter, have a ⅜-in. lift, and are placed on cages with 20 valves on each cage. There are 7 cages on each diaphragm, and the free water-way through the valves on any one diaphragm is about equal to the area of the plunger. The bedplates, carrying main-shaft pillow blocks, rest on masonry piers. The suction pipes run through the engine-pit wall to a wet-well, from which all six of the engines in the house will draw.

Summary and results:

Feed-water per I. HP. per hour, lbs.	11.648
Dry steam per I. HP. per hour, lbs.	11.627
Duty per 1,000 lbs. feed-water ft.-lbs.*	160,166,000
Duty per 1,000 lbs. dry steam, ft.-lbs.	160,455,000
Duty per million B. T. U., ft.-lbs.	143,404,000
B. T. U. per I. HP. per minute	216.84
Mechanical efficiency, %	94.26
Thermodynamic efficiency, %	18.44
Steam pressure in engine room, lbs.	136.0
Indicated HP.	548.71
Total number of expansions	30.6

*Contract.

A New Graphic Method of Constructing the Entropy—Temperature of a Gas or Oil Engine.

This paper, by Mr. Henry T. Eddy, is largely mathematical. It gives a graphical construction by which the entropy diagram may be directly constructed from the indicator card. In the discussion following the paper, it was pointed out that the diagram deduced from the card of a Diesel engine was in error, inasmuch as no allowance had been made for the increase of material in the cylinder upon the introduction of the fuel, but the contents of the cylinder on the expansion side of the card had been assumed to be the same as that of the compression side.

Pressure in Pipe Due to Stoppage of Flowing Liquid.

The above paper, by Mr. Geo. M. Peek, was the last of the Wednesday morning session and was read only by title. An attempt is made to deduce mathematically the pressure in pipes due to the sudden stoppage of a flowing liquid. In the discussion following several members adversely criticised the conclusions arrived at.

In response to an invitation from Col. E. D. Meier, a party of members spent the afternoon in a trip to Newark, N. J., where they inspected a number of Diesel motors in various stages of construction and in operation at the shop of Messrs. Hewes & Phillips.

Liquefaction of Gases.

The evening session was opened by the above paper by Mr. A. L. Rice. The paper will be reprinted in a future issue.

Curved Glass Blue-Print Machine.

The above paper, by Mr. P. M. Chamberlain, was given nearly in full in our last issue.

A Metal Dynagraph.

The subject of the above paper, also by Mr. Chamberlain, is described in the following excerpt:

The machine here described was designed for the purpose of giving a definite test of the machinable qualities of cast-iron specimens, and at the same setting to prepare the specimen for accurate tensile tests. It was built in the shops of the Lewis Institute, and serves as a part of the experimental laboratory equipment.

It consists essentially of a lathe swung as a cradle dynamometer and an autographic apparatus. The lathe is adapted to specimens 18 ins. long. The carriage carries two cross slides, one with the testing tool, and the other with forming tools. The power feed gives 1-48-in. movement per revolution of specimen. The spindle is cast iron with babbitt bearings 1¾ x 2 ins. The end thrust is taken by 20 5-16-in. steel balls and tool steel collars. The cradle bearings are carried on 14 5-16-in. steel balls in tool steel races. The autographic arrangement consists of a pencil attached to the carriage and marks on a concave card concentric with the swing of the machine.

The diagram formed by the pencil shows the pounds pull on, and the distance moved by, the tool. This, with the time of cut, gives the variable factors for the horse-power used. The friction of the machine can be read from the card where the pencil marks before and after the cut. The additional friction when doing work is nearly proportional to the work, presenting no great error, yet one which can be corrected, if so desired.

To secure comparative results, it is necessary to have the tool conditions constant. The subject of rake and clearance angles consistent with the minimum resistance in cutting various metals is a field of investigation in which this machine will be useful.

Education of Machinists, Foremen and Mechanical Engineers.

This excellent paper, by Mr. M. P. Higgins, was given nearly in full in our last issue, and we discussed editori-

nily its recommendations. It excited a greater amount of interest and a more prolonged discussion than any other paper read during the convention. The discussion continued until near the midnight hour, and it was voted to devote a special session to the further discussion of the topics raised by it at the next convention of the society.

Experiment on Using Gasoline Gas for Boiler Heating.

The Thursday morning session was opened by the above paper by Mr. Herman Poole. It describes experiments made to determine the practicability of firing a steam boiler with air gas made from gasoline in a carburetter. The tests were successful as showing that steam could be raised in this way, but the financial results were not encouraging.

Friction of Steam Packings.

This paper was presented by Mr. C. H. Benjamin, and will be found in a future issue.

In the discussion of the paper it was objected by several members that the tests described were of little value in determining the best packing, as the conditions of use differed greatly from the conditions of the test. In the test the motion of the piston rod was not reversed and there was no vibration. It was stated that the proper method of finding the comparative friction of a packing was to measure the wear of the piston rod in a given time.

Friction Tests of a Locomotive Slide Valve.

This paper, by Mr. F. C. Wagner, describes some tests made at the Rose Polytechnic Institute, to determine the power consumed by the valves and valve-gear of a locomotive. The gear was driven by an electric motor, the efficiency of which was known, and readings were made of the power delivered to the motor. In the discussion the criticism was made by a member, that, according to the data given in the paper, the tests were made at excessively high speeds.

Notes on Fly-Wheel Design.

In this paper, by Mr. A. J. Frith, it is proposed to strengthen fly-wheels by causing the arms to take part of the centrifugal force acting on the rim. This is to be accomplished by springing an arched rib between the spokes. The paper was followed by a rather rambling discussion upon fly-wheel design in general. There was a concensus of opinion that most failures of small cast wheels were due to stresses induced in the casting and cooling of the wheels.

A Broken Fly-Wheel, and How It Was Repaired.

In this paper, Mr. James McBride described the method followed in repairing a 26-ft. fly-wheel which had been so strained by the engine running away that numerous cracks were developed in the ribs on the inner side of the rim where the latter was bolted to the arms, and in consequence the outer surface of the rim sprung out of true when the engine was at full speed. To remedy this a pair of wrought-iron tie-rods was attached to each segment, half-way between the spokes, and was secured to plates bolted to the hub. These rods were provided with turnbuckles, and by means of these the rim was brought back into shape. We hope to give a more complete abstract of the paper with the accompanying drawings in a future issue.

Efficiency Test of a 125-HP. Gas Engine.

A working test of a Westinghouse gas engine is described in the above paper, by Mr. C. H. Robertson. The first part of the paper is devoted to a description of the engine, which is substantially like the one described in Engineering News for Sept. 21 of this year.. The maximum load during the test was only three-quarters of the rated power of the engine, and, consequently, very high efficiencies were not reached. The test was valuable, however, as showing that Willans' law holds approximately for this type of gas engine. The line showing the relation between the consumption of gas and the horse-power developed, is nearly a straight line.

Strength of Steel Balls.

Tests of the crushing strength of steel balls were given in this paper, by Mr. J. W. F. Harris. The matter presented consisted largely of a record of results, with but few suggestions that would be of use in actual practice. One member, in discussing the paper, stated that there was very little need of knowing the ultimate crushing strength, but the hardness and elasticity were quite important. Mr. Henning said that only balls of uniform elasticity should be used in the same bearing. Balls could easily be graded for elasticity by dropping them from a fixed height on a hardened steel plate. Those rebounding equally were to be classed together.

Colors of Heated Steel at Different Temperatures.

This paper, which we reprinted last week, was followed by a long and scattered discussion. A valuable device for recognizing a definite temperature was described by one of the members. It consisted of a glass globe containing an electric lamp. The globe was tinted so that when the lamp was burning the outside of the globe had the precise color corresponding to the temperature to which it was wished to bring the iron or steel. This globe was placed where the workman could readily compare it with the material being heated. The great advantage of this device is that the standard and the material are affected in the same amount by variations of light and the personal equation.

At the close of this meeting Mr. John A. Brashear exhibited a diffraction grating, prepared by ruling lines

$$\frac{1}{15{,}000}$$

in. apart on the polished surface of an alloy of copper and tin combined in the proportion of their atomic weights.

The afternoon was occupied by a visit to the power plant of the Waldorf-Astoria Hotel, in response to an invitation from Mr. Henri de Buren, Chief Engineer. In the evening the usual annual reception was held by the President and President-elect at Sherry's, and was attended by a very large number.

Impact.

The closing session of Friday morning was begun by the reading of a paper on "Impact," by Mr. W. J. Keep. The results are given of a long series of tests to determine the action of cast-iron bars under impact, the blows being delivered transversely to the length of the bar and the latter acting as a beam. The author states that he has been unable to devise any mathematical formulæ by which the deflection of a test bar of a given size with a given blow can be computed from the deflection of a test bar of any other size, or from the deflection of a bar of the given size with any other blow. He further states:

There seems no better way to determine the resilience of a material than to support a test bar at the ends and deliver blows at the center. After a test bar has been tested in this way it is desirable to find its resistance to impact without any distortion as a test of brittleness. To do this a portion of the same bar should be clamped on the anvil of a testing machine so that one end shall project. Blows should be delivered on the projecting end. Mr. Barba has suggested taking a test bar of steel 1.181 ins. sq. and filing a notch in the top and bottom, making the depth at that point only 0.835-in. The object of the notches is to prevent any deflection before fracture. For general use it would not be safe to trust to the notches being made alike in shape and depth. For cast iron it would not do to cast the notch, as in cooling the formation of the grains around the notch would greatly weaken the test bar.

For cast iron it would seem best to leave the bar with its original section, and deliver the blows as far from the clamp as 1½ times the depth of the bar, which would be the proportionate distance suggested by Mr. Barba. An inch bar would receive blows 1½ ins. from the clamp and a ½-in. bar ¾-in. from the clamp.

An examination of the diagrams obtained shows that some one size of test bar must be selected for comparisons. The size for cast iron which would seem to give the best results is a bar 1 in. × 1 in. × 24 ins., struck with a 50-lb. hammer. This has the same relative proportions as a bar ½-in. × ½-in. × 12 ins., and if a 25-lb. hammer is used, the record is the same as with a 1-in. × 1-in. × 24-in. bar with a 50-lb. hammer; but this does not take into account the change in grain due to size of casting.

The Southern Terminal at Boston.

This paper was prepared by Mr. Walter C. Kerr, with the assistance of Messrs. Henry J. Conant, William W. Churchill, Francis Blossom, J. P. Coleman and Calvert Townley. It is a comprehensive and detailed description of the New South Station at Boston, Mass., which is one of the largest engineering works ever undertaken by one firm, and certainly the greatest of its kind. The most impressive feature of the paper was that in which it showed the benefits of organization and co-ordination. The paper states:

Within the writer's experience and observation no contract has ever before been executed in which everything came together and worked more perfectly in accomplishing the ends intended than in this, nor is it probable that any contract was ever more efficiently executed in the matter of costs and wastes. All of the conditions surrounding this engineering work, from its first inception to the placing of the last portion in position, were all conducive of the obtaining of the best results at the lowest cost.

It will be noted that this engineering work was conducted on a basis which is growing more prevalent, of entrusting the work of engineering design and construction to the same engineers. This custom seems to have obtained more in mechanical than in any other form of engineering, due, perhaps, to the fact that mechanical engineers and mechanical engineering contractors are more nearly the same type of men than civil engineers and most civil engineering contractors or architects and most builders. Another reason may be that mechanical engineering developed into large proportions long subsequent to other forms of engineering, also subsequent to the opportunities for educational advantages and closely linked with manufacturing processes. It has thus, for reasons not altogether easy to analyze, become the custom for mechanical engineers to associate themselves with manufacturing or contracting corporations.

The growing tendency of purchasers to concentrate the responsibility of design and construction, has further led to the placing of large engineering work in the hands of contractors who first design, and then construct to their own designs and specifications. Whatever be the technical objections to this method of conducting work, or whatever arguments may be urged against its theoretical feasibility, there seems to be no doubt as to the good results of its practice, and the conduction of much work in this line has led the writer and many others to believe that it is one of the best methods yet adopted. There seems to be no incompatibility of relationships, and the universal satisfaction which it has yielded warrants a fair word in its favor. It should, however, be understood that the fact that an engineering concern is so situated as to be able to do such work, in no wise incapacitates it for conducting contracting along the usual lines of bidding to the plans and specifications of others. In a word, the moral law may be deduced that the proper design of many classes of engineering work gains little from so-called disinterestedness, but gains much from a certain balance and gravity which follow only from the close touch with having previously executed such work, and from the realization that the designer must responsibly execute his designs within fixed commercial limitations. In other words, a strong guarantee of accuracy and quality results from concentrated interested responsibility. To moralize further, the virtues of competition are not always realized in certain classes of work, and such work as is described is peculiarly the type which, for the production of the best results, requires a closer intimacy than can ever be gained through the natural channels of competition.

The work was executed within the estimates at a profit; the entire costs were eventually made known to those for whom the work was done, and who congratulated the engineers upon the substantial difference that existed between the cost and the contract price paid. This may not be engineering, but it is very near it.

There are some who consider the execution of engineering work wholly the adaptation of engineering knowledge and principles to the work; but in addition to this the results follow also from good management and constructive independence in displaying the courage of one's convictions, whether along conventional lines or not. In this respect the work forming the subject of this paper was conducted with much care, which, with the attention given to the accuracy of detail design in the working drawings; the exactness with which orders were placed for material; the diligence exercised in securing deliveries, and, lastly, in the organization of the erecting force, conducted the work in such a manner as to keep it moving with systematic progress rather than in the chaotic struggle which results from emergency crowding first at one point and then at another.

The substantial gains in simplicity, first cost, and in operating expense possible with the opportunity to design a complete engineering equipment in which so many kinds of service are involved, each of which is considered merely as branches of one comprehensive system, are known to have been very large. They followed in a larger measure than would otherwise have been possible, because of the opportunities provided at a sufficiently early period to permit conditions and details of other construction to be harmonized with the requirements of the entire system, and to remove obstacles to the employment of the most suitable apparatus and methods.

Thus, while the intrinsic merits of any piece of apparatus were always given due weight, it was possible, where other things were equal or nearly so, to allow considerations of adaptability to the general system to determine a choice, and in this way to simplify the entire system to a great degree. Simplicity in general design, and few kinds of service, not only led to an averaging of the various demands on the source of power, thereby improving conditions and reducing the capacity necessary to provide, but manifestly led to a reduced cost of attention and skill required for operation and maintenance.

The paper was followed by a lengthy discussion turning chiefly on the advisability of a single firm doing both the engineering work and the contracting on a given piece of work. Some members held that there was great danger of the buyer's interests being injured where the contractor was also the inspector of his own work. Others stated that a great amount of work was being poorly done by contractors that should properly come to consulting engineers. Mr. Kerr was asked to state the case from the point of view of the buyer's interests. He answered that probably the chief advantage to the buyer in the present instance was that he obtained better work for less money than he would otherwise have done. One member suggested that a committee should be appointed to look into the matter of establishing a code of professional etiquette governing such cases, but the matter was dropped without action by the society.

High Hydrostatic Pressures and Their Application to Compressing Liquids; A New Form of Pressure Gage.

This paper, by Mr. F. H. Stillman, describes a very powerful press, and, also, a very ingenious pressure gage, by which it is possible to detect differences in pressure of a pound throughout the range of several hundred thousand pounds. The paper will be reprinted in Engineering News in the near future.

The Value of a Horse-Power.

In this paper Mr. George S. Rockwood reviewed portions of the testimony given before the Board of Arbitration appointed to settle the claims of certain mill owners having mills along Kettle Brook and Blackstone River, and using water for power from these streams, against the city of Worcester, Mass., which took for its own use the waters of Kettle Brook. The case turned chiefly upon the question as to whether a horse power, as developed at a water privilege, was a piece of property—a commodity—which might be considered as "on the market," and hence as having a definite market value, known to those who deal in it, as the petitioners claimed, or whether it was simply an easement to the mill owners' estates; namely, the right to have the water come down from above in order that they might make any reasonable use of it which should not appreciably diminish its flow through those premises to others below them, which was the position held by the defense. The paper was taken up with a critical examination of the testimony of certain of the witnesses for the petitioners, in which their statements were vigorously assailed. A somewhat heated discussion followed, dealing mostly with the proper status of expert witnesses. The opinion was generally expressed that the cause of the often unsatisfactory character of expert testimony laid chiefly with the methods of jurisprudence, by which the witness was denied the opportunity of fully stating his position. At the close of the discussion a resolution was offered by Mr. Rockwood requesting the council to appoint a committee to investigate the matter of the proper methods of evaluating water powers. The resolution was adopted.